This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

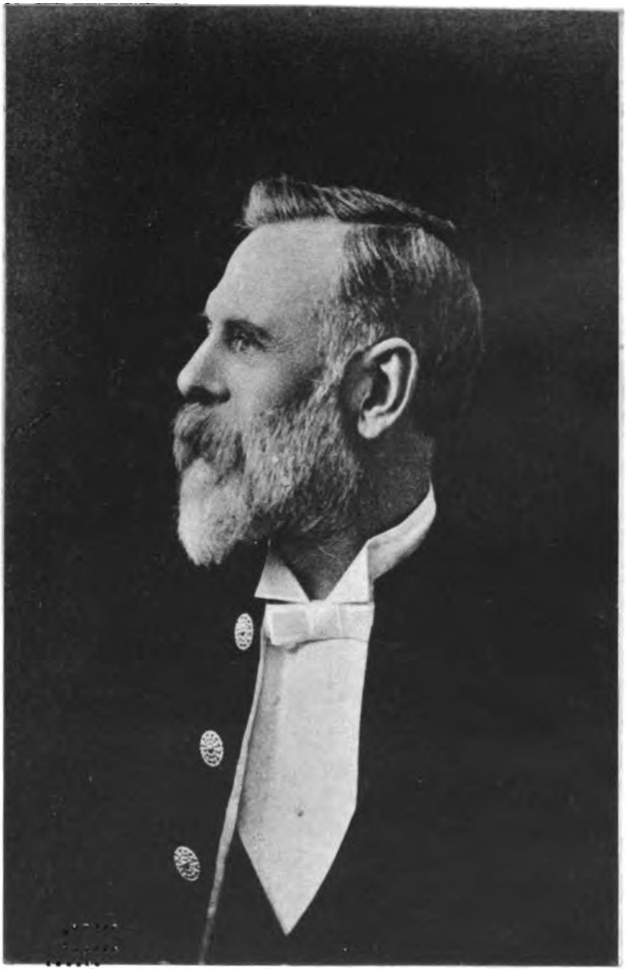
Proceedings

Institution of Municipal Engineers (Great Britain), Association of Municipal and Sanitary Engineers and Surveyors, Incorporated ...

LIBRARY OF THE
UNIVERSITY OF MICHIGAN

DEPARTMENT
OF
ENGINEERING

TA
1
.I93



SIR ALEXANDER R. BINNIE, M. INST. C.E.,
PAST PRESIDENT.

From a photograph by KATE PRAGNELL.

Institution of municipal & county

From a photograph by KATE PRAGNELL.

Institution of municipal & county engineers, Lond.

PROCEEDINGS

OF THE

INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS

VOLUME XXIV. 1897-98

EDITED BY

THOMAS COLE

ASSOC. M. INST. C.E.

(*Secretary of the Association*)

The Association is not as a body responsible for the facts and opinions advanced herein.

London:
E. & F. N. SPON, LIMITED, 125 STRAND
New York:
SPON & CHAMBERLAIN, 12 CORTLANDT STREET
1898

LONDON:
PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET
AND CHARING CROSS.

CONTENTS.

Frontispiece Portrait—
SIR ALEXANDER BINNIE, M. Inst. C.E., *Past President.*

PAGE
LIST OF OFFICERS v
LIST OF MEMBERS vii
LIST OF TOWNS AND DISTRICTS REPRESENTED xxvi
LIST OF GRADUATES xxxix
GENERAL PURPOSES AND FINANCE COMMITTEES xli
BYE-LAWS xliii

ANNUAL REPORT 1
APPOINTMENT OF AUDITORS 6
" " SCRUTINEERS 6
FINANCIAL STATEMENT FOR YEAR ENDING APRIL 30th, 1898 8

DISTRICT MEETINGS—

MEETING AT RHAYADER:
Visit to the Elan Valley and Works for the Water Supply of Birmingham 10

MEETING AT SUNDERLAND:
Notes on the Specifications of Tyneside Roads. H. W. Taylor .. 17
Some Municipal Works in Sunderland. R. S. Rounthwaite (Plates) 24
Sunderland Electric Lighting. J. C. Snell 34
Discussion 41
Visits to Works 50

MEETING AT WESTMINSTER:
Discussions—
The proposed Bill to extend the provisions of the Poor Law Officers' Superannuation Act, 1896 52
The proposed Bill to amend the Metropolitan Officers' Superannuation Act, 1866 52
The proposed Bill to amend the Metropolis Management Acts with respect to Sewers and Drains 60
The proposed Conference of Metropolitan Surveyors called to consider the question of Sewer Ventilation 62
The Collection of House Refuse from Blocks of Flats 80

MEETING AT WIMBLEDON:
Municipal Work at Wimbledon. C. H. Cooper (Plates) 82
Works for the Supply of Electricity at Wimbledon. A. H. Preece 99
Electric Wiring Practice. F. Bathurst 109
Discussion 125
Visits to Works 126

MEETING AT PATELEY BRIDGE:
Visit to the Nidd Valley and Works for the Water Supply of Bradford 128
The Nidd Valley Scheme 128
Visits to Works 131

300522

DISTRICT MEETINGS—*continued.*

MEETING AT NORWICH:

PAGE
Some Municipal Works in Norwich. A. E. Collins 133
Discussion 146
Correspondence 147
Visits to Works 151

MEETING AT GREAT YARMOUTH:

Some of the Recent Works carried out by the Great Yarmouth Town Council. J. W. Cockrill 153
Discussion 167
On the Abuse of Power-Houses. W. H. Preece 175
Discussion 178
Visits to Works 182

ANNUAL MEETING IN EDINBURGH:

The President's Address 184
Tarred Macadam in the Construction of Urban Roads. A. H. Campbell 200
Discussion 209
Experience of Edinburgh with Refuse Destructors. J. Young .. 214
Discussion 236
Conversion of Edinburgh Horse Tramway System into Cable Traction. W. N. Colam 246
Discussion 261
Notes on Sewer Ventilation. A. Stewart 267
Discussion 272
Housing of the Working Classes in Edinburgh. W. Bruce (Plates) 276
Discussion 282
Bacterial Treatment of Sewage. D. Cameron 289
Discussion 292
Two Hours' Test of Steam Ram Pumping Plant. J. B. Wilson .. 306
Discussion 309
The Electric Lighting of Edinburgh. F. A. Newington 311
Discussion 319
Notes on Leith Docks. P. Whyte. (Plates) 327
Discussion 337
Visits to Works 339

APPENDIX:

List of Books of Statistics at Offices of the Association 342
Examinations 348
Board of Examiners 358
Certificated Candidates 359

MEMOIRS OF DECEASED MEMBERS 365

The Incorporated Association of Municipal and County Engineers.

LIST OF OFFICERS, 1898–9.

COUNCIL.

President.

O. C. ROBSON, M. Inst. C.E., Willesden.

Past Presidents.

1873–4 1874–5	LEWIS ANGELL, M. Inst. C.E.
1875–6.	*J. G. LYNDE, M. Inst. C.E.
1876–7.	JAMES LEMON, M. Inst. C.E.
1877–8.	*F. ASHMEAD, M. Inst. C.E.
1878–9.	G. F. DEACON, M. Inst. C.E.
1879–80.	E. PRITCHARD, M. Inst. C.E.
1880–1.	*A. W. MORANT, M. Inst. C.E.
1881–2.	*W. S. TILL, M. Inst. C.E.
1882–3.	C. JONES, M. Inst. C.E.
1883–4.	W. H. WHITE, M. Inst. C.E.
1884–5.	W. G. LAWS, M. Inst. C.E.
1885–6.	*R. VAWSER, M. Inst. C.E.
1886–7.	J. LOBLEY, M. Inst. C.E.
1887–8.	*J. GORDON, M. Inst. C.E.
1888–9.	E. B. ELLICE-CLARK, M. Inst. C.E.
1889–90 1890–91	H. P. BOULNOIS, M. Inst. C.E.
1891–2.	T. DE C. MEADE, M. Inst. C.E.
1892–3.	J. CARTWRIGHT, M. Inst. C E.
1893–4.	J. T. EAYRS, M. Inst. C.E.
1894–5.	A. M. FOWLER, M. Inst. C.E.
1895–6.	E. R. S. ESCOTT, M. Inst. C.E.
1896–7.	F. J. C. MAY, M. Inst. C.E.
1897–8.	Sir ALEX. R. BINNIE, M. Inst. C.E.

* Deceased.

Vice-Presidents.

J. COOPER, Assoc. M. Inst. C.E., Burgh Engineer, Edinburgh.
W. HARPUR, M. Inst. C.E., Borough Engineer, Cardiff.
C. H. LOWE, M. Inst. C.E., Vestry Surveyor, Hampstead.

Ordinary Members of Council.

J. P. BARBER, M. Inst. C.E., Vestry Surveyor, St. Mary, Islington.
A. E. COLLINS, Assoc. M. Inst. C.E., City Engineer, Norwich.
J. H. COX, M. Inst. C.E., Borough Surveyor, Bradford.
A. CREER, Assoc. M. Inst. C.E., City Surveyor, York.
A. T. DAVIS, Assoc. M. Inst. C.E., County Surveyor, Salop.
E. P. HOOLEY, Assoc. M. Inst. C.E., County Surveyor, Nottingham.
E. G. MAWBEY, M. Inst. C.E., Borough Surveyor, Leicester.
J. PATON, Borough Surveyor, Plymouth.
S. S. PLATT, M. Inst. C.E., Borough Surveyor, Rochdale.
J. PRICE, M. Inst. C.E., City Surveyor, Birmingham.
W. WEAVER, M. Inst. C.E., Vestry Surveyor, Kensington.
T. H. YABBICOM, Assoc. M. Inst. C.E., City Engineer, Bristol.

District Honorary Secretaries.

Eastern District.—J. W. COCKRILL, Assoc. M. Inst. C.E., Great Yarmouth.
Home District.—G. B. LAFFAN, Assoc. M. Inst. C.E., Twickenham.
Ireland.—R. H. DORMAN, M. Inst. C.E., Armagh.
Lancashire and Cheshire District.—J. COOK, Assoc. M. Inst. C.E., Lancaster.
Metropolitan District.—G. R. W. WHEELER, Assoc. M. Inst. C.E., Westminster.
Midland District.—J. S. PICKERING, Assoc. M. Inst. C.E., Nuneaton.
Northern District.—J. P. DALTON, Ryton-on-Tyne.
Wales (North).—J. W. M. SMITH, Wrexham.
„ (South).—W. E. C. THOMAS, Assoc. M. Inst. C.E., Neath.
Western District.—JOS. HALL, Assoc. M. Inst. C.E., Cheltenham.
Yorkshire District.—T. W. STAINTHORPE, Assoc. M. Inst. C.E., Eston.

General Hon. Secretary.

C. JONES, M. Inst. C.E., Ealing.

Honorary Treasurer.

LEWIS ANGELL, M. Inst. C.E., West Ham.

Secretary.

THOMAS COLE, Assoc. M. Inst. C.E., 11 Victoria Street, London, S.W.

Telegraphic Address:
"Bisecting, London."

Telephone Number:
"588 Westminster."

LIST OF MEMBERS.

IT IS PARTICULARLY REQUESTED THAT EVERY CHANGE OF ADDRESS MAY BE COMMUNICATED WITHOUT DELAY TO THE SECRETARY.

** Those Members against whose names a star is placed have obtained the Certificate of the Association.*

HONORARY MEMBERS.

BECHMANN, MONSIEUR	Ingénieur en chef des Ponts et Chaussées, Paris.
CAREY, MAJOR-GENERAL C. PHIPPS	Local Government Board, Whitehall.
CODRINGTON, THOS., M. Inst. C.E.	5 Riverdale Rd., Twickenham Park.
LAMBRETCHSEN VAN RITTHEM, C.L.M., C.E.	Director of Public Works, Amsterdam.
MANSERGH, JAS., V.P. Inst. C.E.	5 Victoria Street, Westminster.
PUTZEYS, E.	Ingénieur en chef, Directeur de la Ville de Bruxelles.
ROBINSON, HY., M. Inst. C.E.	13 Victoria St., Westminster, S.W.
TAYLOR, ARNOLD, C.E.	Local Government Board, Whitehall.
TULLOCH, MAJOR H., R.E.	Local Government Board, Whitehall.

MEMBERS.

ABRAHAMS, C. V.	City Surveyor, Kingston, Jamaica.
ABURROW, C., M Inst. C.E.	Town Engineer, Johannesberg, S.A.
ADSHEAD, E. E.	Borough Surveyor, Macclesfield.
AITKEN, T., A.M. Inst. C.E.	County Surveyor, Cupar, Fife.
ALLEN, A. T.	Surveyor to Urban District Council, Portslade-by-Sea, Sussex.
ALLEN, T. T.	Broad Street, Stratford-on-Avon.
ALVES, G.	Surveyor to Urban District Council, Glastonbury.
ANDERSON, R. S., Assoc. M. Inst. C.E.	County Surveyor, Peebles, N.B.
ANDREWS, G. R.	228 Willesden Lane, N.W.
*ANGELL, J. A., A.M.Inst.C.E.	Surveyor to Urban District Council, Beckenham.
ANGELL, LEWIS, M. Inst. C.E. (*Past President, and Hon. Treasurer.*)	Borough Engineer, West Ham.
ARMISTEAD, R., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bingley, Yorkshire.
ARMYTAGE, W. K. L.	Borough Surveyor, Yeovil.
ATKINSON, J., A.M. Inst. C.E.	Borough Surveyor, Stockport.
*ATKINSON, W.	Surveyor to Rural District Council, Kiveton Park. Top Hall, Thorpe Salvin, Worksop.

BAFF, C. J.	Surveyor to Urban District Council, Gosforth, Newcastle-on-Tyne.
BAKER, F.	Borough Surveyor, Middlesbrough, Yorks.
BAKER, J., A.M. Inst. C.E.	Surveyor, Slough.
BALDWIN, L. L., A.M. Inst. C.E.	Surveyor to the Urban District Council, Coalville, Leicester.

*Ball, B., Assoc. M. Inst. C.E.	Borough Surveyor, Nelson, Lancs.
*Ball, G., A.M. Inst. C.E.	Surveyor to the Urban District Council, Bexhill.
Banks, W., A.M. Inst. C.E.	City Surveyor, Rochester.
Barber, J. P., M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, St. Mary, Islington.
*Barnes, S. W. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hanwell.
Barras, C. C.	Surveyor to Rural District Council, Doncaster.
Barratt, F. W.	Vestry Surveyor, Bethnal Green.
Barrett, E. J., Assoc. M. Inst. C.E.	Surveyor, Staines.
Barton, J.	Surveyor to Urban District Council, St. Helens, Isle of Wight.
Baylis, T. P., A.M.Inst.C.E.	Borough Surveyor, Droitwich.
Beatson, W.	Borough Surveyor, Leith.
Beaumont, A.	County Surveyor, County Hall, Beverley.
Beaumont, G. E.	Surveyor to Rural District Council, Wortley.
Beaumont, T. C	Surveyor to Rural District Council, Driffield.
Bell, A. W., A. M. Inst. C.E.	City Engineer, Dunfermline.
Bell, G., Assoc. M. Inst. C.E.	Borough Surveyor, Swansea.
Bell, G. J., A. M. Inst. C.E.	County Surveyor, Cumberland.
Bellingham, A. W. H., Assoc. M. Inst. C.E.	Municipal Engineer, Tientsin, China.
Bennett, C. G.	Surveyor to Urban District Council, Oystermouth.
Bennett, H. M.	Surveyor to Rural District Council, Keynsham, Bristol.
Bennett, W. B. G., Assoc. M. Inst. C.E.	Borough Surveyor, Southampton.
Berrington, R. E. W., Assoc. M. Inst. C.E.	Graisley, Wolverhampton.
Beswick, W. H., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Exmouth.
Bettany, F.	Borough Engineer, Burslem.
Biker, T.	Surveyor to U. D. Council, Barnoldswick, Yorks.
BINNIE, SIR A. R., M. Inst. C.E. (*Past President.*)	Chief Engineer, London County Council, Spring Gardens, S.W.
Bird, W. F.	Surveyor to Urban District Council, Midsomer Norton.
Birks, E.	Surveyor to Rural District Council, Wycombe.
Bishop, McW.	Surveyor to the Urban District Council, Sutton-in-Ashfield, Notts.
Blackshaw, W., Assoc. M. Inst. C.E.	Borough Surveyor, Stafford.
Blair, W. N., M. Inst.C.E.	Vestry Surveyor, Vestry Hall, St. Pancras.
Boden, E. G.	Surveyor to the Rural District Council, Romford.
Botterill, C., A.M.Inst.C.E.	Town Hall, Walham Green.
BOULNOIS, H. P., M. Inst. C.E. (*Past President.*)	44 Campden House Court, Kensington.
Bower, J.	Borough Engineer, Gateshead-on-Tyne.
Bowen, H. W.	Surveyor, Leintwardine.
Bowles, A. R., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sandgate.
Boyle, J. C.	City Surveyor, Armagh.
Bradford, J. H.	Surveyor to Urban District Council, Aylesbury.
*Bradley, J. W., Assoc. M. Inst. C.E.	Borough Engineer, Wolverhampton.
Bradley, W. L.	Surveyor to Urban District Council, Tonbridge.
*Bradshaw, F. E. G.	Surveyor to Urban District Council, Trowbridge.
Bressey, J. T.	Surveyor to the Urban District Council, Wanstead, Essex.
Bretland, J. C., M. Inst.C.E.	City Surveyor, Belfast.
Brett, J. H.	County Surveyor, Co. Antrim. Belfast, Ireland.

Brettell, W. H.	Surveyor to the Urban District Council, Rowley Regis, Staffordshire.
Bridges, O. A.	Surveyor to the Urban District Council, Bognor.
Brierley, J.H., A.M.Inst C.E.	Borough Surveyor, Richmond, Surrey.
Brierley, R.	Town Surveyor, Newton-in-Makerfield, Lancashire.
Brockbank, W. H.	Borough Surveyor, Bolton.
Brodie, J. S., A.M. Inst. C.E.	Town Surveyor, Whitehaven.
Brooke, J.	Surveyor to the Urban District Council, Northwich, Cheshire.
Brooke, W., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Strood, Kent. Meopham, Gravesend.
Broom, G. J. C., M.Inst. C.E.	Borough Engineer, St. Helen's, Lancashire.
Brown, A., M. Inst. C.E.	Borough Engineer, Nottingham.
Brown, Chas.	Burgh Surveyor, Airdrie, N.B.
Brown, C.	Surveyor to Urban District Council, Bedlingtonshire.
Brown, J. W., Assoc. M.Inst. C.E.	Borough Engineer, West Hartlepool.
Brown, P. H., M. Inst. C.E.	District Engineer, Godaveri, Madras.
*Brown, R., A.M. Inst. C.E.	Vestry Surveyor, Stoke Newington.
*Brown, R. R.	Electrical Engineer to the Urban District Council, Bridlington.
Brown, W. I.	Borough Surveyor, Northampton.
Brown, W. T.	Surveyor to Rural District Council, Clown.
Brownridge, C., Assoc. M. Inst. C.E.	Borough Engineer, Birkenhead.
Buckham, E., M. Inst. C.E.	Borough Surveyor, Ipswich.
Buckley, M. J., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Drumcondra.
Bull, H. F., A.M. Inst. C.E.	County Surveyor, Cheshire.
Bunting, T. F.	Borough Surveyor, Maidstone.
Burden, A. M., Assoc. M. Inst. C.E.	County Surveyor, Kilkenny.
Burgess, S. E., Assoc. M. Inst. C.E.	Borough Engineer, South Shields.
Burslam, R.	Borough Surveyor, Congleton.
Burton, J. H.	Surveyor to the Urban District Council, Audenshaw, Lancashire.
Busbridge, T. A.	Surveyor to Rural District Council, Spilsby.
Butler, W.	Surveyor to the Urban District Council, Fareham.
Button, F. S., M. Inst C.E.	Consulting Borough Surveyor, Burnley. Blannel Street, Burnley.

Caink, T., Assoc.M.Inst. C.E.	City Engineer, Worcester.
Cairncross, T. W., Assoc. M. Inst. C.E.	Surveyor, Cape Town, S.A.
Calvert, W.	Surveyor to the Urban District Council, Hebden Bridge.
Cameron, D.	City Surveyor, Exeter.
Campbell, A. H., Assoc. M. Inst. C.E.	City Surveyor, Canterbury.
Campbell, K. F., Assoc. M. Inst. C.E.	Borough Engineer, Huddersfield.
Capon, E. R.	Surveyor to the Urban District Council, Epsom.
Card, H.	County Surveyor, Sussex (East). Lewes.
Carline, J., A. M. Inst. C.E.	District Surveyor, Lewisham. Catford Hill, S.E.
Carter, G. F., A.M.Inst.C.E.	Surveyor to Urban District Council, Mexborough.
CARTWRIGHT, J., M. Inst. C.E. (*Past President.*)	Borough Surveyor, Bury, Lancashire.

Cass, R. W.	Surveyor to the Urban District Council, Pudsey, Yorks.
Catt, A. J.	Surveyor to the Urban District Council, Sandwich.
Chadwick, J.	Surveyor to the Urban District Council, Fenny Stratford.
Chapman, C. R. W.	Surveyor to Urban District Council, Swaffham.
Charles, T.	Surveyor to the Urban District Council, Harrow.
Chart, R. M.	Consulting Surveyor to the Rural District Council, Croydon. Vestry Hall, Mitcham, Surrey.
Christie, J.	City Electrical Engineer, Londonderry.
Clare, J., A.M. Inst. C.E.	Surveyor to the Urban District Council, Sleaford.
Clark, E. O'N.	County Surveyor, Leitrim.
Clarke, A. M.	Surveyor to the Urban District Council, Witham.
Clarry, W. H.	Borough Surveyor, Sutton Coldfield.
Clarson, H. J.	Borough Surveyor, Tamworth.
Clough, W.	Surveyor to the Urban District Council, Atherton.
*Coales, H. F.	Surveyor to the Urban District Council, Sunbury-on-Thames.
*Coales, H. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Market Harborough.
Cockrill, J. W., A. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Great Yarmouth; *Hon. Secretary*, Eastern District.
Cockrill, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Haverhill, Suffolk.
Collen, W., M.A., B.E., A.M. Inst. C.E.	County Surveyor, Dublin. 9 Hume Street, Dublin.
Collingwood, T. A.	Surveyor to Urban District Council, Itchen, Woolston, Southampton.
Collins, A. E., A.M.Inst.C.E. (*Member of Council.*)	City Engineer, Norwich.
Collins, R.	Surveyor to the Urban District Council, Enfield, N.
Comber, A.	Borough Surveyor, Kidderminster.
Comber, P. F., M. Inst. C.E.	Town Surveyor, Bray. 19 Lower Leeson Street, Dublin.
Cook, F. P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Mansfield Woodhouse.
*Cook, J., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Lancaster; *Hon. Secretary*, Lancashire and Cheshire District.
Cooke, E.	Surveyor to the Urban District Council, Abersychan, Pontypool.
*Cooper, C. H., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Wimbledon.
Cooper, E. C.	Surveyor to Urban District Council, Shanklin, Isle of Wight.
Cooper, F. A., M. Inst. C.E.	Director of Public Works, Colombo, Ceylon.
Cooper, J., Assoc.M. Inst. C.E. (*Vice-President.*)	Burgh Engineer, Edinburgh.
Cooper, W. W.	Surveyor to Urban District Council, Slough.
Copland, C. A.	Surveyor to Urban District Council, Sheerness.
Copley, C. T., Assoc. M.Inst. C.E.	252 Barkerhouse Road, Nelson, Lancashire.
Corbett, J.	Borough Engineer, Salford.
Cordon, R. C.	Surveyor to the Rural District Council, Belper. Hazelwood, Derby.
*Corrie, H. W.	Surveyor to Urban District Council, Neston.
Cotterell, A. P. I., Assoc. M. Inst. C.E.	Surveyor, Rural District Council, Barton Regis. 7 Baldwin Street, Bristol.
Coverley, J. S.	Surveyor, Penmaenmawr.
Cowan, P. C., M. Inst. C.E.	County Surveyor, Down, Ireland.
Cowling, J. C.	Surveyor to Urban District Council, Cockington.
Cox, J.	Surveyor to the Urban District Council, Margam, Port Talbot.

Cox, J. H., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Bradford.
Crabtree, W. H. R., Assoc. M. Inst. C.E.	Borough Surveyor, Doncaster.
Creer, A., Assoc. M. Inst. C.E. (*Member of Council.*)	City Surveyor, York.
Crimp, W. Santo, M. Inst. C.E.	27 Great George Street, S.W.
*Crowther, J. A., Assoc. M. Inst. C.E.	Borough Surveyor, Bootle.
Currall, A. E.	Surveyor to the Rural District Council, Solihull, Warwickshire.
Curry, W. F.	Surveyor to the Urban District Council, Morpeth.
Curry, W. T., A. M. Inst. C.E.	Wentwood Waterworks, near Caerleon, Mon.
Cutler, H. A., A.M. Inst. C.E.	City Surveyor, Cork.
*Dalton, J. P. (*Member of Council.*)	Surveyor to the Urban District Council, Ryton-on-Tyne; *Hon. Secretary*, Northern District.
Davies, R.	Borough Surveyor, Brecknock.
Davies, W. A., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Heston and Isleworth. Town Hall, Hounslow.
Davis, A. T., Assoc. M. Inst. C.E. (*Member of Council.*)	County Surveyor, Salop.
Dawson, C. J.	Surveyor to the Urban District Council, Barking.
Dawson, N. H.	Borough Surveyor, Banbury.
Dawson, W., M. Inst. C.E.	Surveyor to the Urban District Council, Leyton.
Day, C.	Borough Surveyor, Chatham.
DEACON, G. F., M. Inst. C.E. (*Past President.*)	32 Victoria Street, Westminster, S.W.
Deane, J.	Surveyor to Urban District Council, Smallthorne.
*Dearden, H., A. M. Inst. C.E.	Borough Engineer, Dewsbury.
Debnam, A. W.	Surveyor to the Urban District Council, East Stonehouse, Devon.
Dennis, N. F., A.M. Inst. C.E.	Surveyor to Urban District Council, Aldershot.
Dent, W.	Railway Street, Nelson, Lancashire.
Deverell, T. C., Assoc. M. Inst. C.E.	City Engineer, Town Hall, Perth, W. Australia.
Dewhirst, J.	Surveyor to the Rural District Council, Guildford.
Dickinson, R.	Surveyor to Urban District Council, Berwick-on-Tweed.
Dickinson, T. R., Assoc. M. Inst. C.E.	6 Selbourne Grove, Manningham, Bradford.
Diggle, J., A.M. Inst. C.E.	Water Engineer, Heywood.
Diggle, Wm.	Surveyor, Frodsham, Chester.
Ditcham, H.	Borough Surveyor, Harwich.
Diver, D. J.	Surveyor to Urban District Council, Wirksworth.
Dixon, E. K., M.E., M. Inst. C.E.	County Surveyor, Castlebar, Mayo.
Dixon, F. E., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Walton-le-Dale. 49 Lune Street, Preston.
Dixon, F. J., A.M. Inst. C.E.	29 Broadgate, Lincoln.
Dixon, J. R., A.M. Inst. C.E.	Vestry Surveyor, Shoreditch.
*Dixon, R., Assoc. M. Inst. C.E.	Borough Surveyor, Stratford-on-Avon.
Dodd, P., Assoc. M. Inst. C.E.	Surveyor, Wandsworth, S.W.
Dodgeon, A.	Surveyor to the Urban District Council, Clayton-le-Moors.
Dorman, R. H., M. Inst. C.E. (*Member of Council.*)	County Surveyor, Armagh; *Hon. Secretary*, Irish District.
Dormer, P. C.	Surveyor to the Urban District Council, Raunds, Northamptonshire.
Duffin, W. E. L., M. Inst. C.E. I.	County Surveyor, Waterford, Ireland.

Dunn, J.	Surveyor to Rural District Council, Chesterton.
Dunscombe, C., M.A., M. Inst. C.E.	32 Victoria Street, Westminster, S.W.
Dyack, W., M. Inst. C.E.	Burgh Surveyor, Aberdeen.
Dyer, S.	Surveyor, Bridlington.

Earnshaw, J. T., Assoc. M. Inst. C.E.	Borough Surveyor, Ashton-under-Lyne, Lancashire.
Eaton-Shore, G., Assoc. M. Inst. C.E.	Borough Surveyor, Crewe.
EAYRS, J. T., M. Inst. C.E. (*Past President.*)	39 Corporation Street, Birmingham.
Ebbetts, D. J.	Surveyor to the Urban District Council, Acton.
Eckersley, W.	Surveyor to the Urban District Council, Chadderton, Lancashire.
Eddowes, W. C.	Borough Surveyor, Shrewsbury.
*Edge, F. J., A. M. Inst. C.E.	City Surveyor's Office, Manchester.
Edinger, P.	Surveyor to Urban District Council, Frome.
*Edmondson, S.	Surveyor to Rural District Council, Burnley.
Edson, W.	City Surveyor, Ripon.
Edwards, T. L.	County Surveyor, Glamorgan.
*Elford, E. J.	Surveyor to Urban District Council, Portland.
Elford, J.	Borough Surveyor, Poole.
ELLICE-CLARK, E. B., M. Inst. C.E. (*Past President.*)	34 Victoria Street, Westminster, S.W.
Ellis, R. E., M. Inst. C.E.	Municipal Engineer, Madras.
Entwisle, H.	Surveyor to the Urban District Council, Swinton.
ESCOTT, E. R. S., M. Inst. C.E. (*Past President.*)	Borough Engineer, Halifax.
Evans, A. J. L.	Borough Surveyor, Luton.
Evans, E., A. M. Inst. C.E.	County Surveyor, Carnarvonshire.
Evans, E. I., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Penarth, South Wales.
Evans, J. P.	Surveyor to the Rural District Council, Wrexham.

Fairley, W., A.M. Inst. C.E.	Richmond Main Sewerage Board, Mortlake, S.W.
Farrall, T.	Surveyor to Urban District Council, Sherborne, Dorset.
Farrington, T. B.	Borough Engineer, Conway.
Farrington, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hoyland Nether.
Feather, F.	Surveyor to Urban District Council, Chepstow.
Featherstone, H. E.	Borough Engineer, Chesterfield.
Felkin, H. R.	Surveyor to the Urban District Council, Southall Norwood.
Fenn, T.	Surveyor to Urban District Council, Belper.
*Fiddian, W.	Town Surveyor, Stourbridge.
Findlay, R., A.M. Inst. C.E.	Surveyor to the Parish of Eltham, Plumstead.
Fitton, G.	Borough Surveyor, Basingstoke.
Fleming, M. J.	Borough Surveyor, Town Hall, Waterford.
Flower, T. J. M., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Portishead, near Bristol. Carlton Chambers, Baldwin Street, Bristol.
*Forbes, A. H.	Surveyor to the Urban District Council, Chesham, Bucks.
Ford, G.	City Surveyor, St. Albans.
Forder, W. G., A.M. Inst. C.E.	"Sunnydale," Thornton Heath.
Forrester, R.	Surveyor to Rural District Council, Basingstoke.

Foster, T.	Surveyor to the Urban District Council, Hoylake and West Kirby.
FOWLER, ALFRED M., M. Inst. C.E. (*Past President.*)	1 St. Peter's Square, Manchester; and 35 Old Queen Street, Westminster, S.W.
Fox-Allin, C. J.	Surveyor to Urban District Council, Smethwick.
*Franks, T.W., A.M.Inst. C.E.	Albion Street, Lewes.
Fraser, A. O., A.M. Inst. C.E.	Surveyor to the Urban District Council, Allerton, Liverpool.
Fraser, W., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Llandaff, Cardiff. 17 Queen's Chambers, Cardiff.
Frost, H.	Surveyor to the Urban District Council, Gosport and Alverstoke. Gosport.
Fry, W. H., A.M. Inst. C.E.	9 High Street, Gosport.

Gamble, S. G., Assoc. M. Inst. C.E.	Metropolitan Fire Brigade, Southwark Bridge Road.
Gammage, J.	Borough Surveyor, Dudley.
Gammell, H. H.	Surveyor to the Urban District Council, Perry Barr, near Birmingham.
Garratt, C. T.	Surveyor to the Urban District Council, Ashby Woulds. Market Street, Ashby-de-la-Zouch.
Garrett, J. H.	County Surveyor, Worcester.
Gaskell, P.	Surveyor to the Urban District Council, Hornsea, near Hull.
Gaulter, M. S.	Town Surveyor, Fleetwood.
Geen, H.	Borough Surveyor, Okehampton.
Ginn, A. F.	District Surveyor to the Kent County Council, Tonbridge. Salisbury Villa, Quarry Road, Tonbridge.
Glover, E., M.A., B.E., M. Inst. C.E.	County Surveyor, Kildare, Ireland; 19 Prince Patrick Terrace, North Circular Road, Dublin.
*Gloyne, R. M., Assoc. M.Inst. C.E.	Borough Surveyor, Eastbourne.
Goddard, D. C.	Borough Surveyor, Kendal.
Godfrey, B., A.M. Inst. C.E.	Surveyor to the Rural District Council, Rotherham.
Godfrey, R., Assoc. M. Inst. C.E.	Market Jew Street, Penzance.
Golder, T. C.	Borough Surveyor, Deal.
Goldsworth, W.	Surveyor to the Urban District Council, Prescot, Lancashire
Goodyear, H., Assoc. M.Inst. C.E.	Borough Surveyor, Colchester.
Gordon, F.	Surveyor to the Rural District Council, Halifax. Clifton, Brighouse.
Gow, W. C.	Vestry Surveyor, Vestry Hall, Plumstead.
Graham, G. A.	Surveyor to the Urban District Council, Witney.
*Graves, M. D.	Surveyor, Bexhill.
Gray, R. A.	Late County Surveyor, Dublin.
*Greatorex, A. D., Assoc. M. Inst. C.E.	Borough Surveyor, West Bromwich.
Green, A. A.	Borough Surveyor, Brackley.
Green, W.	Surveyor to Urban District Council, Castleford.
Greenwell, A., Assoc. M. Inst. C.E.	5 Arundel Street, Strand.
Greenwood, A.	39 Calder Street, Todmorden.
Gregory, T.	Surveyor to the Urban District Council, Newburn-on-Tyne. Isle of Ely C. C.
Gregson, G.	Surveyor to the Rural District Council, Durham.

Gregson, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Padiham, near Burnley.
Grieves, R.	Surveyor to the Urban District Council, Cowpen, Blyth, Northumberland.
Grieves, W. H.	Surveyor to the Urban District Council, Buxton.
Griffiths, F.	Corporation Waterworks Engineer, Leicester.
Grimley, S. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hendon.
Gunnis, J. W.	County Surveyor, Longford, Ireland.
Gunyon, C. J., A.M. Inst. C.E.	Surveyor to Urban District Council, Wood Green.
Hackett, E. A., M.E., M. Inst. C.E.	County Surveyor, Clonmel, Tipperary, Ireland.
Haigh, J., A.M. Inst. C.E.	Town Surveyor, Abergavenny.
Hainsworth, M.	Surveyor to the Urban District Council, Teddington.
Hague, S.	Surveyor to Urban District Council, Dukinfield.
Hall, J., Assoc. M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Cheltenham; *Hon. Secretary*, Western District.
Hall, W., A.M. Inst. C.E.	Surveyor to Urban District Council, Great Crosby.
Hamar, A.	Borough Surveyor, Bishop's Castle, Shropshire.
Hamby, G. H., A M. Inst. C.E.	Borough Engineer, Lowestoft.
Hamp, H. J., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, New Swindon.
Hanson, J. H.	Surveyor to the Urban District Council, Heath Town.
Hanson, W.	Surveyor to the Rural District Council, Wantage.
Hara, R.	Engineer to Tokio Fu, Japan.
Harding, J. R., M. Inst. C.E.	Surveyor, Epsom, Surrey.
Hare, F. H.	Surveyor to the Urban District Council, Mirfield.
Harlock, H., A.M. Inst. C.E.	8 Clifton Terrace, Southend-on-Sea.
Harpur, A. O.	Surveyor to Urban District Council, Caerphilly.
Harpur, W., M. Inst. C.E. (*Vice-President.*)	Borough Engineer, Cardiff.
Harris, F.	Surveyor to the Rural District Council, Tonbridge. Bidborough. Tunbridge Wells.
Harston, W., A.M. Inst. C.E.	Surveyor to the Urban District Council, Dartford.
Hartley, T. H.	Borough Surveyor, Colne.
Harty, S., M. Inst. C.E. I.	City Engineer, Dublin.
Harvey, E. J.	Surveyor to the Urban District Council, Ventnor.
Harvey, T. F., Assoc. M. Inst. C E.	Engineer to the Urban District Council, Merthyr Tydvil.
***Hawkings**, S. T.	Surveyor to the Urban District Council, Bromley.
Hawkins, L T., Assoc. M. Inst. C.E.	Colonial Institute, Northumberland Avenue, S.W.
Hawley, G. W.	Surveyor to the Rural District Council, Basford. York Chambers, King Street, Nottingham.
Haycroft, J. J., A. M. Inst. C.E.	Borough Engineer, Woollahra, Sydney.
***Haynes**, R. H.	Borough Engineer, Newport, Mon.
Hayward, T. W. A.	Borough Surveyor, Sudbury, Suffolk.
Heath, G. A.	"The Hollies," Malden Road, Watford.
Heaton, G., Assoc. M. Inst. C.E.	Surveyor to Urban District Councils, Abram, Aspull, Orrell and Pemberton. King Street, Wigan.
Henderson, A. J., Assoc. M. Inst. C.E.	Surveyor to the District Highway Board, Kingston.
Henby, T.	Surveyor to Rural District Council, East Retford.
Heron, J., B.E., B.A.	County Surveyor, Monaghan, Ireland

Heward, T. L.	30 Elgin Road, Croydon.
Hewson, T., M. Inst. C.E. ..	Borough Engineer, Leeds.
Hickes, T. J...	County Surveyor, Cornwall (W. division), Truro.
Higgens, T. W. E., Assoc. M. Inst. C.E.	Vestry Surveyor, Vestry Hall, Chelsea.
Higgins, J.	Chief Engineer, Grey Co., New Zealand.
Hind, H.	Surveyor to the Urban District Council, Erith.
Hirst, R. P.	Borough Surveyor, Southport.
Hodge, J. L., Assoc. M. Inst. C.E.	22 Courtenay Street, Plymouth.
Hodgson, W.	Surveyor to the Urban District Council, Keswick.
Hodson, G., M. Inst. C.E. ..	Loughborough. Abbey Buildings, Prince's Street, Westminster, S.W.
Hogbin, L. W.	Surveyor to the Rural District Council, Isle of Thanet.
Holden, A.	Surveyor to the Urban District Council, Hindley.
Holden, J., A.M. Inst. C.E.	Surveyor to the Rural District Council, Llandaff. Ely, Cardiff.
Hole, W. P.	Borough Surveyor, Montgomery.
Hollings, G.	Surveyor to the Urban District Council, Wallsend.
Holmes, G. W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Walthamstow.
Holt, G. F.	"Redcliffe," Prince's Road, Romford.
Hooley, Cosmo C., Assoc. M. Inst. C.E.	Surveyor to the R. D. C., Barton-upon-Irwell, and U. D. C., Urmston, near Manchester. Green Lane, Patricroft.
Hooley, E. P., A.M.Inst.C.E. (*Member of Council.*)	County Surveyor, Nottingham.
Hope, W. H.	Surveyor to the Rural District Council, Kingston-on-Thames.
Hopkinson, F.	Surveyor to the Rural District Council, Blyth and Cuckney. Poplar House, Watson Road, Worksop.
Hopkinson, W. H., A.M.Inst. C.E.	Borough Engineer, Keighley.
Horan, J., M.E., M.Inst.C.E.	County Surveyor, 50 George Street, Limerick, Ireland.
Horsfall, W. H. D.	Surveyor to Urban District Council, Southowram. 9 Harrison Road, Halifax.
Horton, G. S.	Surveyor to Urban District Council, Felixstowe.
Howard, H.	Surveyor to Urban District Council, Littlehampton.
Howard, S.	Surveyor to Urban District Council, Bradford-on-Avon.
Howcroft, J.	Surveyor to the Urban District Council, Kirkleatham. Redcar, Yorkshire.
Howell, F. G.	County Surveyor, Kingston-on-Thames.
Howell, J.	Surveyor, Glyncorrwg.
Howse, W. T.	Surveyor to the Urban District Council, Hinckley.
Hughes, H. T.	Surveyor to the Rural District Council, Tarvin. Tilston, Malpas.
Hughes, R.	Surveyor to the Urban District Council, Rhyl.
Humphreys, J.	Surveyor to the Urban District Council, Maesteg.
Hunt, G. J.	Borough Engineer, Dorchester.
Hunter, T.	Surveyor to the Urban District Council, Leigh.
***Hurd**, H.	Surveyor to Urban District Council, Broadstairs.
Huxley, J.	Surveyor to Rural District Council, Hailsham.

Ingamells, E. W...	Surveyor to Urban District Council, Pokesdown.
***Ingham**, W., A. M. Inst. C.E	Water Engineer, Torquay.

Irving, W. E.	Surveyor to the Municipal Shire of Toowong, near Brisbane, Queensland.
Isaacs, L. H.	Surveyor to the Holborn District B. W., 3 Verulam Buildings, Gray's Inn Road.

Jackson, N.	County Surveyor, Co. Cork (West Riding), Bandon, Co. Cork.
Jaffrey, W.	Town Surveyor, Matlock Bath.
James, A. C., A.M. Inst. C.E.	Surveyor to the Urban District Council, Grays Thurrock. Grays.
*Jameson, M. W.	Surveyor to Urban District Council, South Hornsey.
Jarvis, R. W.	Surveyor to Rural District Council, Tenbury.
Jeeves, E.	Surveyor to the Urban District Council, Melton Mowbray.
*Jenkin, C. J., A.M. Inst. C.E.	Surveyor to Urban District Council, Willenhall.
Jennings, G.	Borough Surveyor, Rotherham.
Jepson, J.	Surveyor to Urban District Council, Levenshulme.
Jevons, J. H., A. M. Inst. C.E.	Borough Surveyor, Hertford.
Johnston, J., Assoc. M. Inst. C.E.	Waterworks Engineer, Brighton.
Jones, A. S., Lt.-Col., V.C., Assoc. M. Inst. C.E.	Ridge Cottage, Finchampstead, Berks.
JONES, C., M. Inst. C.E. (*Past President and General Hon. Secretary.*)	Surveyor to the Urban District Council, Ealing, Middlesex.
Jones, Christopher	Surveyor to Urban District Council, Teignmouth.
Jones, C. B.	County Surveyor, Sligo.
Jones, I. M., M. Inst. C.E.	City Surveyor, Chester; Engineer to the Dee Bridge Commissioners.
Jones, J.	Surveyor to the Rural District Council, Hengoed, *viâ* Cardiff.
Jones, J. O.	Surveyor to the Urban District Council, Biggleswade.
Jones, R.	Borough Surveyor, Aberystwyth.
Jones, W., Assoc.M.Inst.C.E.	Surveyor to Urban District Council, Colwyn Bay.
Jones, W. J.	Surveyor to the Urban District Council, Rhondda.
Jones, W. P.	Surveyor to Urban District Council, Glyncorrwg.
Jukes, W. H.	Surveyor to the Urban District Council, Tipton.

Kay, W. R.	Surveyor to the Urban District Council, Irlam.
Kemp, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Hampton, Middlesex.
Kennedy, J. D.	Borough Surveyor, Retford.
Keywood, H. G.	Surveyor to the Rural District Council, Maldon.
Kidd, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Swadlincote, Burton-on-Trent.
Kilford, H. J.	Borough Surveyor, Ilkeston, Derbyshire.
King, W.	Surveyor to the Rural District Council, Blaby. Alliance Chambers, Municipal Square, Leicester.
Kirk, T., Assoc. M. Inst. C.E.	"Rushton," Lytton Road, East Brisbane, Queensland.
Kirkby, S. A., M.A.	County Surveyor, Cork (South division), East Riding. Miramur, Queenstown.
Knapp, R. W.	Surveyor to the U.D.C., Farnborough, Hants.
Knight, J. M.	Vestry Surveyor, Mile End.
Knowles, G. W., Assoc. M. Inst. C.E.	Town Surveyor, Clevedon, Somerset.
Kurata, Y.	Engineer to Tokio Fu, Japan.

LACEY, F. W., M.Inst. C.E.	Borough Engineer, Bournemouth.
*LACEY, G. W.	Borough Surveyor, Saffron Walden.
LAFFAN, G. B., Assoc.M.Inst. C.E. (*Member of Council.*)	City Engineer, Pietermaritzburg; *Hon. Secretary,* Home District.
LANDLESS, J. T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Brierfield, Lancs. Station Buildings, Nelson.
LATHAM, A., M. Inst. C.E.	Borough Engineer, Margate.
LAURENS, F., A.M. Inst. C.E.	Surveyor to the Rural District Council, Cookham.
LAW, E.	County Surveyor, Northampton.
LAWS, W. G., M. Inst. C.E. (*Past President.*)	City Engineer, Newcastle-on-Tyne.
LAWSON, A.W., A.M.Inst.C.E.	Borough Surveyor, Rawtenstall.
LAWSON, C. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Southgate. District Offices, Palmer's Green, N.
LEEBODY, J. W.	County Surveyor, Co. Tyrone (S.).
LEETE, H. J. G	49 Bassaleg Road, Newport, Mon.
LEETE, W. H., A.M.Inst.C.E.	County Surveyor, Bedford.
LEIGH, W.	Borough Surveyor, Chorley.
LEMON, J., M. Inst. C.E. (*Past President.*)	Consulting Engineer, Southampton; and 9 Victoria Street, Westminster.
LEWIS, T. L., A.M. Inst. C.E.	"Abbeville," St. George, Bristol.
LILLEY, G. H.	Surveyor to the Urban District Council, Ashby-de-la-Zouch.
LIVINGSTONE, G., Assoc. M. Inst. C.E.	Vestry Surveyor, St. George, Hanover Square. 1 Pimlico Road, S.W.
LOBLEY, J., M. Inst. C.E. (*Past President.*)	Borough Engineer, Hanley, Staffordshire.
LOCKE, W. R.	Surveyor to Urban District Council, Caversham.
LOCKWOOD, P. C., M. Inst. C.E.	Surveyor, Brighton.
LOMAX, C. J., Assoc. M. Inst. C.E.	Grosvenor Chambers, Deansgate, Manchester.
LONGFIELD, R. W. F., Assoc. M. Inst. C.E.	County Surveyor, Co. Donegal (S.).
LOVEGROVE, E. J., Assoc. M. Inst. C.E.	Engineer to the Urban District Council, Hornsey.
LOWE, C. H., M. Inst. C.E. (*Vice-President.*)	Vestry Surveyor, Hampstead.
LUMSDEN, J. L.	Burgh Surveyor, Kirkcaldy.
LUND, C.	Surveyor to Urban District Council, Cleckheaton.
LUND, J.	Borough Surveyor, Bedford.
LYNAM, F. J., A.M Inst. C.E.	County Surveyor, Co. Tyrone (N.).
LYNAM, G. T., A.M. Inst. C.E.	Borough Surveyor, Burton-on-Trent.
*LYNAM, P. J.	County Surveyor, Louth. Dundalk, Ireland.
LYONS, A. O., M. Inst. C.E.	County Surveyor, Co. Cork (East), Mallow.

MCBEATH, A. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sale, Cheshire.
MACBRAIR, R. A., Assoc. M. Inst. C.E.	City Engineer, Lincoln.
MACDONALD, A. B., M. Inst. C.E.	City Engineer, Glasgow.
MACDONALD, D. G., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Rugby.
MACKENZIE, D.	County Surveyor, Dunfermline.
MCKENZIE, J. McD.	Surveyor to the Rural District Council, Bucklow. 7 Market Street, Altrincham.
MCKENZIE, J.	Surveyor to Rural District Council, Wing and Eaton Bray.
MCKIE, H. U., M. Inst. C.E.	11 Victoria Street, Westminster, S.W.

McKillop, R.	Burgh Surveyor, Perth, N.B.
Madin, W. B.	Surveyor to the Urban District Council, Rushden.
Magee, F. W.	Surveyor to Rural District Council, Walsall.
Mair, H., Assoc. M. Inst. C.E.	Surveyor to the Parish of Hammersmith.
*Mallinson, T.	Surveyor to the Urban District Council, Skipton.
Manley, J.	Borough Surveyor, Wokingham.
Mann, J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Sevenoaks.
Manning, G. W.	Surveyor to the Urban District Council, Staines.
Marks, H. C., A.M. Inst. C.E.	City Surveyor, Carlisle.
Marks, T. T., A.M. Inst. C.E.	Surveyor, Llandudno, Carnarvonshire.
Marshall, J.	Surveyor to Rural District Council, West Malling.
Marston, C. F., Assoc. M. Inst. C.E.	44 High Street, Sutton Coldfield.
Marten, H. J., Assoc. M. Inst. C.E.	District Surveyor, Streatham. 158 High Road, Streatham.
Marten, T.	Surveyor to Urban District Council, Radstock.
Mason, C., Assoc. M. Inst. C.E.	Beeston, Notts.
Massie, F., A.M. Inst. C.E.	Surveyor to the Rural District Council, Wakefield.
Mathew, C., A.M. Inst. C.E.	Borough Surveyor, Ryde.
Mathews, G. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Dorking.
Mawbey, E. G., M. Inst. C.E. (*Member of Council.*)	Borough Engineer, Leicester.
Mawson, R. C.	Borough Surveyor, Evesham.
MAY, F. J. C., M. Inst. C.E. (*Past President.*)	Borough Engineer and Surveyor, Brighton.
Maybury, H. P.	Surveyor to the Urban District Council, Great Malvern.
Mayne, C., Assoc. M. Inst. C.E.	Engineer and Surveyor to the Municipal Council, Shanghai; *Hon. Corresponding Sec.* for Eastern Asia.
MEADE, T. DE COURCY, M. Inst. C.E. (*Past President.*)	City Surveyor, Manchester. Kenmore, Didsbury, Manchester.
Mellor, T. E. W., Assoc. M. Inst. C.E.	Borough Surveyor, Tunbridge Wells.
Metcalf, J. W., Assoc. M. Inst. C.E.	Town Surveyor, Newmarket.
*Middleton, R. H., Assoc. M. Inst. C.E.	Borough Surveyor, Walsall.
*Miller, H., M. Inst. C.E.	County Surveyor, East Suffolk, Ipswich.
Mills, J. H.	Surveyor to the Urban District Council, Crompton, near Oldham.
Milnes, G. P., A.M. Inst. C.E.	Surveyor to the Urban District Council, Stroud.
Mitchell, J.	Borough Surveyor, Hyde, Manchester.
Molineux, W. F. Y.	Surveyor to R. D. C., New Winchester, Hants. 2 St. James Street, Winchester.
*Moncur, J., A.M. Inst. C.E.	County Highway Surveyor, Staffordshire.
Monson, H., A.M. Inst. C.E.	Vestry Surveyor, St. James, Westminster.
Moore, J. H.	County Surveyor, Co. Meath. 63 Eccles Street, Dublin.
Morgan, E. F.	Borough Road Surveyor, Croydon.
Morgan, G. S.	Surveyor to the Rural District Council, Llantrissant, Glamorgan.
Morgan, J.	Surveyor to the Rural District Council, Pontardawe. Swansea.
Morgan, W. B., Assoc. M. Inst. C.E.	Borough Surveyor, Weymouth and Melcombe Regis, Dorsetshire.
Morris, F. J.	Borough Surveyor, Grantham.
Mortimer, J.	Surveyor to the Urban District Council, Tettenhall, near Wolverhampton.

Mosley, A.	Surveyor to the Urban District Council, Finedon.
Mountain, A. H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Withington, near Manchester.
Mulvany, C. J.	County Surveyor, Roscommon.
Murch, P.	Borough Engineer, Portsmouth.
Murphy, P. E., A.M.Inst.C.E.	Engineer to the Urban District Council, Tottenham.
Murzban, M. C., C.I.E., M. Inst. C.E.	Executive Engineer, Bombay.
Myatt, J.	Town Surveyor, Leek.

Nankivell, H. H.	Surveyor to Urban District Council, Braintree.
*Naylor, W., A.M. Inst. C.E.	16 Walton's Parade, Preston.
*Nettleton, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Weston-super-Mare.
Newman, F.	County Surveyor, Isle of Wight. Ryde.
Newman, S. J.	Surveyor to Urban District Council, Branksome.
Newton, C. E.	Surveyor to the Urban District Council, Bowdon, Cheshire. 17 Cooper Street, Manchester.
Newton, G. H.	Surveyor to the Urban District Council, Denton, Manchester.
Newton, W. J., A.M.Inst.C.E.	Borough Surveyor, Accrington.
Nichols, T. W.	Surveyor to the Urban District Council, Methley.
Norrington, J. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Lambeth. Vestry Hall, Kennington Green.
*Norris, J. H.	Borough Surveyor, Godalming.
Norrish, G. R.	Vestry Surveyor, St. Saviour, Southwark.
Nuttall, T., Assoc. M. Inst. C.E.	Surveyor to the Urban District Councils, Kearsley and Ramsbottom, Lancs. 20 Market Street, Bury, Lancs.

Orchard, W. P., B.E.	County Surveyor, Ballina, North Mayo, Ireland.
Oxtoby, W., A.M. Inst. C.E.	Vestry Surveyor, Vestry Hall, Camberwell.

*Palliser, W. A.	Surveyor to Urban District Council, Featherstone.
Palmer, F. W. J.	Surveyor to Urban District Council, Herne Bay.
Pardoe, J. C., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Barry, near Cardiff.
*Parr, W.	Surveyor to the Urban District Council, West Bridgford.
Parker, J., A.M. Inst. C.E.	City Surveyor, Hereford.
Parker, J., A.M. Inst. C.E.	212 Mansfield Road, Nottingham.
Parker, J. E., A.M.Inst.C.E.	P.O. Chambers, St. Nicholas Square, Newcastle-on-Tyne.
Parker, S. W.	Surveyor to Urban District Council, Thornhill.
Parkinson, J., Assoc. M. Inst. C.E.	Surveyor, Turton, near Bolton.
Parr, F., Assoc. M. Inst. C.E.	Borough Surveyor, Bridgwater.
Parr, N.	Surveyor to the Urban District Council, Brentford.
Paterson, A. R.	Burgh Surveyor, Renfrew, N.B.
Paton, J. (*Member of Council.*)	Borough Engineer, Plymouth.
Pattison, W. P.	Surveyor to the Urban District Council, Benwell and Fenham.
Peacock, T. J.	Surveyor to the Rural District Council, Spalding.
Pearson, W. T.	Surveyor to the Urban District Council, Rothwell, Northants.
Pease, C. R.	Borough Surveyor, Todmorden.
Peirce, R., Assoc.M.Inst.C.E.	c/o R. M. Christie, 98 Cannon Street, E.C.
Penty, W. G.	Surveyor to the Rural District Council, York.
Perrins, B.	Surveyor to Rural District Council, Halesowen.

Perry, J., M.E., M.Inst.C.E.	County Surveyor, Co. Galway (West Riding), Galway.
Petch, W. J.	Surveyor to Urban District Council, Rawmarsh.
Petree, M., A.M. Inst. C.E.	Borough Surveyor, Great Grimsby.
Phillips, R., A.M. Inst. C.E.	County Surveyor, Gloucester.
Picker, E.	Surveyor to Rural District Council, Beverley.
*Pickering, J. S., Assoc. M. Inst. C.E. (*Member of Council.*)	Surveyor to Urban District Council, Nuneaton; *Hon. Secretary*, Midland District.
Pickering, R.	11 Lowther Street, Whitehaven.
*Pickering, S. A., A.M.I.C.E.	Borough Surveyor, Oldham.
*Pickles, G.H., A.M.Inst.C.E.	Borough Surveyor, Burnley.
Pilditch, J. T.	Surveyor to the Parish of Battersea.
Platt, S. S., M. Inst. C.E. (*Member of Council.*)	Borough Surveyor, Rochdale.
Plowright, A. H.	Borough Engineer, Wisbech, Cambs.
Pollard, J., M. Inst. C.E.	31 Old Queen Street, Westminster.
Poole, H. C.	Surveyor to the Urban District Council, Wath upon-Dearn.
Porter, R.	Borough Surveyor, Wakefield.
Pratt, R.	Borough Surveyor, Henley-on-Thames.
Prescott, W. H.	Borough Surveyor, Reigate.
Press, W. J.	Surveyor to the Urban District Council, Burnham, Somerset.
Price, J., M. Inst. C.E. (*Member of Council.*)	City Surveyor, Birmingham.
PRITCHARD, EDWARD, M. Inst. C.E. (*Past President.*)	37 Waterloo Street, Birmingham; and 1 Victoria Street, Westminster, S.W.
Proctor, J., M. Inst. C.E.	Mere Lawn, Bolton, Lancashire.
Prouse, O. M., Assoc. M. Inst. C.E.	Surveyor to Urban District Council, Ilfracombe.
Purnell, E. J.	Water Engineer, Coventry, Warwickshire.
*Putman, W. E., A. M. Inst. C.E.	Borough Surveyor, Morley.
Pym-Jones, I.	Borough Surveyor, Lymington.

Radford, J.C., A.M.Inst.C.E.	District Surveyor, Putney.
Rapley, W.	Surveyor to the Rural District Council, Dorking.
Rayner, F. J.	Surveyor to Urban District Council, Newhaven.
Read, R., A.M.Inst. C.E.	City Surveyor, Gloucester.
Renwick, R.	Surveyor to the Urban District Council, Horsham.
Reynolds, E. J., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Friern Barnet.
Richards, H.	51 Grosvenor Road, S.W.
Richards, R. W., Assoc. M. Inst. C.E.	City Surveyor, Sydney, N.S.W.; *Hon. Corresponding Secretary* for Australasia.
Richardson, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Aston Manor.
Richardson, J.	Surveyor to Urban District Council, Stamford.
Richardson, R.	Surveyor to the Urban District Council, Malton.
Ridout, A. R.	Surveyor to the Urban District Council, Stone.
Riley, G.	Surveyor to Urban District Council, Calverley.
Riley, H.	Surveyor to the Urban District Council, Gainsborough.
Roberts, D.	Borough Surveyor, Lewes.
*Roberts, F., A. M. Inst. C.E.	Borough Engineer, Worthing.
Robinson, A. B.	Surveyor to Urban District Council, Clacton-on-Sea.

Robinson, W. P.	Surveyor to the Urban District Council, Skelton-in-Cleveland.
Robinson, W. J.	City Surveyor, Londonderry.
ROBSON, O. C., M. Inst. C.E. (*President.*)	Surveyor to the Urban District Council, Willesden, Middlesex.
Rodwell, A.	Surveyor to the Rural District Council, Skipton.
Rodley, F.	Surveyor to Urban District Council, Whitworth.
Rogers, W. E.	Surveyor to the Urban District Council, Rugely.
Rooke, J. W. B., Assoc. M. Inst. C.E.	Surveyor to the Rural District Council, Biggleswade, Beds.
Ross, John C., A.M. Inst. C.E.	Town Engineer, Warrnambool, Victoria, Australia.
Ross, P., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, North Bierley, Bradford.
Rothera, F.	Surveyor to the Urban District Council, Sowerby Bridge.
Rounthwaite, R. S., Assoc. M. Inst. C.E.	Borough Engineer, Sunderland.
Rowland, J.	District Surveyor, Plumstead (Charlton Parish). 155 Church Lane, Old Charlton, Kent.
Royle, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Stretford, Lancashire.
Ruck, F. W.	County Surveyor, Kent. Maidstone.
Rushbrooke, T. J.	Borough Surveyor, High Wycombe.
Rushton, E.	Surveyor to the Urban District Council, Cleethorpes.

Sadler, G. W.	467 High Street, Cheltenham.
Saise, A. J., Assoc. M. Inst. C.E.	Surveyor, Stapleton, Bristol.
Salmon, A., Assoc. M. Inst C.E.	Surveyor, Liscard, Cheshire.
Sanders, R. B., B.E., M. Inst. C.E.	County Surveyor, King's County. Parsonstown.
*Sasse, G. H.	Borough Surveyor, Chelmsford.
*Saunders, J.	City Surveyor, Chichester.
Savage, W. H., A.M.Inst.C.E.	Surveyor to Urban District Council, East Ham.
Saville, J.	Town Surveyor, Heckmondwike.
Scorgie, N., A.M. Inst. C.E.	Vestry Surveyor, Rotherhithe, S.E.
Scott, A. F.	Surveyor to the Urban District Council, Cromer.
Scott, H. H., A.M.Inst.C.E.	Engineer to the Commissioners, Hove.
Scott, R. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Bishop's Stortford.
Scott, T.	Surveyor to Rural District Council, Tadcaster.
Senior, C. E.	Surveyor to Urban District Council, Upholland.
Senior, J. S.	Surveyor to the Urban District Council, Swanage.
*Settle, J. A., A.M. Inst. C.E.	Borough Engineer and Surveyor, Heywood.
*Shackleton, C. W.	Surveyor to Urban District Council, Coseley.
Sharman, E.	Surveyor to Urban District Council, Wellingborough, Northamptonshire.
Sharpe, J. E.	Borough Engineer, Clitheroe.
Shaw, H., Assoc.M.Inst.C.E.	Surveyor to Urban District Council, Ilford.
Shaw, J. H.	Surveyor to the Urban District Council, Brownhills, Staffs.
Sheard, W. C., Assoc.M. Inst. C.E.	Surveyor to the Urban District Council, Heaton Norris, Stockport.
Shepherd, G. J.	Highway Surveyor, Kidderminster.
Sheppard, G.	Borough Surveyor, Newark.
Shillington, H., M.E.	Town Surveyor, Lurgan, Ireland.
Shipton, T. H.	Surveyor to the Urban District Council, Oldbury.

Siddons, J. M.	Surveyor, Oundle.
Sidwell, H. T.	Surveyor to the Blean Rural District Council Herne, Canterbury.
*Silcock, E. J., A.M.Inst.C.E.	Surveyor, King's Lynn.
Silcock, H.	Surveyor to the Rural District Council, Blackwell, Mansfield.
Simpson, J.	10 Queen Street Place, London, E.C.
Simpson, W. H., A.M.Inst.C.E.	Horsefair Street, Leicester.
Sinclair, J. S., A.M.Inst.C.E.	Borough Surveyor, Widnes.
Skelton, R., A.M. Inst. C.E.	Municipal Engineer, Colombo, Ceylon.
Smales, J. E.	Surveyor to the Urban District Council, Woodford.
Smillie, J. F.	Borough Surveyor, Tynemouth.
Smith, C. Chambers	Surveyor to the Urban District Council, Sutton, Surrey.
Smith, I. C.	Surveyor to the Rural District Council, Chelmsford.
Smith, J., Assoc. M. Inst. C.E.	County Surveyor, Co. Galway (E. Riding), Ballinasloe.
Smith, J.	Borough Surveyor, Buckingham.
Smith, J. B.	Surveyor to Urban District Council, Tyldesley.
Smith, J. C., A.M. Inst. C.E.	Borough Surveyor, Bury St. Edmunds.
Smith, J. W. M. (*Member of Council.*)	Borough Surveyor, Wrexham, Denbighshire; *Hon. Secretary*, Wales District.
Smith, T. R., A.M. Inst. C.E.	Surveyor to the Urban District Council, Kettering.
Smith, V.	Surveyor to Urban District Council, Houghton-le-Spring.
Smith, W. H., A.M. Inst. C.E.	"Naworth," Lanercost Road, Tulse Hill Park.
*Smith-Saville, R. W., Assoc. M. Inst. C.E.	Borough Surveyor, Darwen.
Smithies, A.	Surveyor to the Urban District Council, Trent Boulevard, West Bridgford.
Smythe, F.	Surveyor to Urban District Council, Finchley, N.
Snell, J., A.M. Inst. C.E.	Borough Electrical Engineer, Sunderland.
Southam, A., A M. Inst. C.E.	Surveyor, Clapham, S.W.
Spencer, J. P., A.M.Inst.C.E.	13 Grainger Street West, Newcastle-on-Tyne.
Spinks, W., Assoc. M. Inst. C.E.	31/32 Prudential Assurance Buildings, Park Row, Leeds.
Stainthorpe, T. W., A.M.Inst. C.E. (*Member of Council.*)	Surveyor to Eston District Urban District Council, Yorkshire; *Hon. Sec.*, Yorkshire District.
Stallard, S., A.M. Inst. C.E.	Surveyor to Rural District Council, Maidstone.
Stansfield-Brun, J.	Surveyor to Urban District Council, Oystermouth.
Stead, S.	Borough Surveyor, Harrogate.
Stephenson, E. P., Assoc. M. Inst. C.E.	Town Surveyor, Llandudno.
Stevens, G.	Surveyor to the Urban District Council, Abercarn, Mon.
Stevens, L.	Surveyor to the Urban District Council, Newton Abbott, Devon.
Stevenson, A.	District Surveyor, Ayrshire County Council.
Stevenson, J.	Surveyor to the Urban District Council, East Molesey.
Stickland, E. A., Assoc. M. Inst. C.E.	Borough Surveyor, Windsor.
Stilgoe, H. E., A.M.Inst.C.E.	Borough Engineer and Surveyor, Dover.
Stirrat, J.	Municipal Engineer, Rangoon.
Stokoe, J.	Surveyor to Urban District Council, Altrincham.
Story, J. S., M. Inst. C.E.	County Surveyor, Derby.
Stow, J. F.	Surveyor to Urban District Council, Bridlington.
Strachan, J., C.I.E., M. Inst. C.E.	Municipal Engineer, Kurachi.
*Stringfellow, H. W.	2 Southampton Road, Eastleigh.
Stringfellow, W., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Eastleigh, Hants.

Stubbs, W., A.M. Inst. C.E.	Borough Engineer, Blackburn.
Sugden, W. L.	Surveyor to the Rural District Council, Stoke.
*Sumner, F., A.M. Inst. C.E.	Vestry Surveyor, Bermondsey.
Surtees, R. T.	Wentworth Place, Hexham-on-Tyne.
Swarbrick, J., Assoc. M. Inst. C.E.	83 Brasenose Street, Albert Square, Manchester.
*Sykes, E., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Cheadle, Manchester.

Tanner, W.	County Surveyor, Monmouthshire. Newport.
Tarbit, T. H.	Surveyor to the Urban District Council, Loftus, Yorkshire.
Taylor, H. W., Assoc. M. Inst. C.E.	Nicholas Chambers, Amen Corner, Newcastle-on-Tyne.
Taylor, R.	Borough Surveyor, Haslingden.
*Taylor, W. J., A.M. Inst. C.E.	County Surveyor, Hants. Winchester.
Terrill, W.	Surveyor to the Urban District Council, Ashford, Kent.
*Thomas, J., A.M. Inst. C.E.	Surveyor to the Rural District Council, Swansea.
Thomas, R. J., A. M. Inst. C.E.	County Surveyor, Bucks. Aylesbury.
Thomas, T. J., A.M. Inst. C.E.	Surveyor to the Urban District Council, Ebbw Vale.
Thomas, W. E. C., A.M. Inst. C.E. (*Member of Council.*)	Surveyor to the Rural District Council, Neath; *Hon. Secretary*, South Wales District.
Thompson, G. W., Assoc. M. Inst. C.E.	Vestry Surveyor, St. Olave, Southwark. Vine Street, Tooley Street, S.E.
Thorburn, T. C.	17 Devonshire Road, Birkenhead.
Thorpe, J.	Surveyor to Rural District Council, Macclesfield.
Thropp, J.	County Surveyor, Lindsey, Lincolnshire.
Thwaites, W., M. Inst. C.E.	Chief Engineer to the Metropolitan Board of Works, Melbourne.
*Tomes, G. B., A.M. Inst. C.E.	Surveyor to the Barnes District Urban District Council, Mortlake.
Tomlinson, S.	Municipal Engineer, Singapore.
Tooley, H.	Surveyor to the Urban District Council, Buckhurst Hill, Essex.
Towlson, S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Cheshunt.
Travers, W. H.	Surveyor to Urban District Council, Wallasey.
Tressider, W. H.	Borough Surveyor, Falmouth.
Trinder, C. D. M.	Surveyor to the Rural District Council, Claypole, Newark.
Trow, S.	Surveyor to the Urban District Council, Otley, Yorkshire.
Turley, A. C., A.M. Inst. C.E.	Borough Engineer, Eccles.
Turnbull, A. J.	Borough Engineer, Greenock.
Turner, H. H.	Surveyor to Rural District Council, Stockport.
Turriff, A. A.	Burgh Surveyor, Elgin, N.B.

Vallance, R. F.	Borough Surveyor, Mansfield.
Valon, W. A. McIntosh, Assoc. M. Inst. C.E.	Ramsgate Corporation Gas-works Engineer. 140 and 141 Temple Chambers, Temple Avenue, E.C.
Veevers, H., A. M. Inst. C.E.	Engineer to the Gas-works, Dukinfield.
Ventris, A., Assoc. M. Inst. C.E.	Surveyor to the Strand District Board of Works. "Campton," Arkwright Road, Hampstead.
Vickers, T.	Surveyor to the Urban District Council, Bexley.
Vincent, S. J. L.	Borough Surveyor, Newbury.

Waddington, J. A. P., Assoc. M. Inst. C.E.	Vestry Surveyor, Whitechapel.
Wakelam, H. T., Assoc. M. Inst. C.E.	County Surveyor, Middlesex. Guildhall, Westminster.
Walker, A. H.	Borough Surveyor, Loughborough.
Walker, T., M. Inst. C.E.	Borough Surveyor, Croydon, Surrey.
Wallace, G.	Surveyor to St. Giles' District Board of Works.
Walshaw, J. W.	Borough Surveyor, Peterborough.
Warburton, C.	Surveyor to the Urban District Council, Audley.
Wardle, J. W., A.M.Inst.C.E.	Borough Surveyor, Longton.
Warne, D.	Surveyor to Urban District Council, Sidmouth.
Waterhouse, D.	Surveyor to the Urban District Council, Watford.
Watkeys, G., A.M.Inst.C.E.	Surveyor to the Urban District Council, Llanelly.
Watson, J. D., A.M.Inst.C.E.	County Engineer, Aberdeenshire.
Watts, E. T.	Surveyor to the Rural District Council, Bishop's Stortford.
Watts, W.	Water Engineer, Langsett, near Penistone.
Weaver, W., M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Kensington.
Webb, J. A.	Surveyor to the Rural District Council, Hendon. Great Stanmore.
Webster, R. J.	Surveyor to the Urban District Council, Castleton, Manchester.
Welburn, W.	Borough Surveyor, Middleton, near Manchester.
Weston, G.	Vestry Surveyor, Paddington.
Weston, H. J., Assoc. M. Inst. C.E.	Surveyor, Southampton.
Wetherill, J. W.	Borough Surveyor, Richmond, Yorks.
Wheeler, G. R. W., Assoc. M. Inst. C.E. (*Member of Council.*)	Vestry Surveyor, Westminster; *Hon. Secretary*, Metropolitan District.
Whitbread, R.	Surveyor to the Urban District Council, Carlton, Notts.
White, A. E., M. Inst. C.E.	Borough Engineer, Hull.
White, H. V., M. Inst. C.E. I.	County Surveyor, Queen's County. Portarlington.
White, J., Assoc.M.Inst.C.E.	Borough Surveyor, Folkestone.
WHITE, W. H., M. Inst. C.E. (*Past President.*)	City Engineer, Oxford.
Whitehead, C. L., jun.	Surveyor to the Urban District Council, Wembley.
Whitehead, H. M.	Surveyor to the Rural District Council, Cannock, Staffs.
Widdowson, W. C.	Surveyor to the Urban District Council, Tredegar, Mon.
Wike, C. F., M. Inst. C.E.	City Surveyor, Sheffield.
Wild, G. H.	Surveyor to Urban District Council, Littleborough, near Manchester.
Wilding, J.	Surveyor to the Urban District Council, Runcorn.
Willcox, J. E., Assoc. M. Inst. C.E.	68 Temple Row, Birmingham.
Williams, H. Dawkin	Surveyor to the Urban District Council, Ogmore and Garrw, Blackmill R.S.O., Bridgend.
Williams, J. B.	Borough Surveyor, Daventry.
Williams, J.	Surveyor to the Urban District Council, Mountain Ash.
Williams, M.	Surveyor to Urban District Council, Bridgend.
Willmot, J.	County Surveyor, Warwickshire. 6 Waterloo St., Birmingham.
Wilson, A.	County Surveyor, Dumbartonshire.
*Wilson, C. L. N., Assoc. M. Inst. C.E.	Town Surveyor, Bilston.
Wilson, G.	Surveyor to the Urban District Council, Alnwick.

*Wilson, J.	Borough Surveyor, Bacup, Lancashire.
Wilson, J. B.	Surveyor to the Rural District Council, Cockermouth.
Window, E. R., A.M.Inst.C.E.	16 Cook Street, Liverpool.
Winning, D.	Burgh Surveyor, Broughty Ferry, N.B.
Winship, G., A.M. Inst. C.E.	Borough Surveyor, Abingdon, Berks.
Winter, O. E., Assoc. M. Inst. C.E.	Surveyor to the Board of Works, Poplar.
Wood, A.	Surveyor to Urban District Council, Ashington.
Wood, A. R.	Surveyor to the Urban District Council, Tunstall.
Wood, F. J., A. M. Inst. C.E.	County Surveyor, Hubert Place, Lancaster.
Wood, W. E.	Surveyor to the Urban District Council, Church.
Woodbridge, C. A.	Surveyor, Pinner, Middlesex.
Woods, H.	District Surveyor, Plumstead (Parishes of Lee and Kidbrook). Dryden Terrace, Turner Road, Lee, Kent.
Worrall, E.	Surveyor to Urban District Council, Penmaenmawr.
Worth, J. E., M. Inst. C.E.	District Engineer, London County Council, Spring Gardens, S.W.
Wyand, B.	Surveyor to Urban District Council, Wealdstone.
Wynne-Roberts, R. O., Assoc. M. Inst. C.E.	City Engineer, Cape Town.
Yabbicom, T. H., Assoc. M. Inst. C.E. *(Member of Council.)*	City Engineer, Bristol.
Yates, F. S., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, Waterloo, near Liverpool.
York, H., Assoc. M. Inst. C.E.	Surveyor to the Urban District Council, East Barnet Valley. Station Road, New Barnet.

TOWNS AND DISTRICTS

REPRESENTED BY MEMBERS OF THE ASSOCIATION.

H.	*signifies*	Home District.	West	*signifies*	Western District.
Met.	„	Metropolitan District.	N.	„	Northern District.
M.	„	Midland District.	E.	„	Eastern District.
Y.	„	Yorkshire District.	W.	„	Welsh District.
L. & C.	„	Lancashire and Cheshire District.	I.	„	Irish District.
			A.	„	Abroad.

TOWN.	DISTRICT.	NAME.
Abercarne	West.	G. Stevens.
Aberdeen	N.	W. Dyack.
Aberdeenshire	N.	J. D. Watson.
Abergavenny	West.	J. Haigh.
Abersychan	W.	E. Cooke.
Aberystwyth	W.	R. Jones.
Abingdon	H.	G. Winship.
Abram	L. & C.	G. Heaton.
Accrington	L. & C.	W. J. Newton.
Acton	H.	D. J. Ebbetts.
Airdrie, N.B.	N.	C. Brown.
Aldershot	H.	N. F. Dennis.
Allerton	L. & C.	A. O. Fraser.
Alnwick	N.	G. Wilson.
Altrincham	L. & C.	J. Stokoe.
Antrim (County)	I.	J. H. Brett.
Armagh	I.	J. Boyle.
Armagh (County)	I.	R. H. Dorman.
Ashby-de-la-Zouch	M.	G. H. Lilley.
Ashby Woulds	M.	C. T. Garratt.
Ashford	H.	W. Terrill.
Ashington	N.	A. Wood.
Ashton-under-Lyne	L. & C.	J. T. Earnshaw.
Aspull	L. & C.	G. Heaton.
Aston Manor	M.	H. Richardson.
Atherton	L. & C.	W. Clough.
Audenshaw	L. & C.	J. H. Burton.
Audley	M.	C. Warburton.
Aylesbury	H.	J. H. Bradford.
Ayrshire (County)	N.	A. Stevenson.
Bacup	L. & C.	J. Wilson.
Banbury	H.	N. H Dawson.
Barking	H.	C. J. Dawson.
Barmouth	W.	T. Blackburn.
Barnes	H.	G. B. Tomes.

TOWN.	DISTRICT.	NAME.
Barnoldswick	Y.	T. Biker.
Barrow-on-Soar (Rural)	M.	H. Herrod.
Barry	W.	J. C. Pardoe.
Barton Regis (Rural)	West.	A. P. I. Cotterell.
Barton-upon-Irwell (Rural)	L. & C.	C. C. Hooley.
Basford (Rural)	M.	G. W. Hawley.
Basingstoke	H.	G. Fitton.
Basingstoke (Rural)	H.	R. Forrester.
Battersea	Met.	J. T. Pilditch.
Beckenham	H.	J. A. Angell.
Bedford	H.	J. Lund.
„ (County)	H.	W. H. Leete.
Bedlingtonshire	N.	C. Brown.
Belfast	I.	J. C. Bretland.
Belper	M	T. Fenn.
„ (Rural)	M.	R. C. Cordon.
Benwell	N.	W. P. Pattison.
Bermondsey	Met.	F. Sumner.
Berwick-on-Tweed	N.	R. Dickinson.
Bethnal Green	Met.	F. W. Barratt.
Beverley	Y.	E. Picker.
Bexhill	H.	G. Ball.
„	H.	M. D. Graves.
Bexley	H.	T. Vickers.
Biggleswade	H.	J. O. Jones.
„	H.	J. W. B. Rooke.
Bilston	M.	C. L. N. Wilson.
Bingley	Y.	R. Armistead.
Birkenhead	L. & C.	C. Brownridge.
Birmingham	M.	J. Price.
Bishop's Castle	M.	A. Hamar.
Bishop's Stortford	H.	R. S. Scott.
„ „ (Rural)	H.	E. T. Watts.
Blaby (Rural)	M.	W. King.
Blackburn	L. & C.	W. Stubbs.
Blackwell (Rural)	M.	H. Silcock.
Blean (Rural)	H.	H. T. Sidwell.
Blyth and Cuckney (Rural)	M.	F. Hopkinson.
Bognor	H.	O. A. Bridges.
Bolton	L. & C.	W. H. Brockbank.
Bombay	A.	M. C. Murzban.
Bootle	L. & C.	J. A. Crowther.
Bournemouth	H.	F W. Lacey.
Bowdon	L. & C.	C. E. Newton.
Brackley	M.	A. A. Green.
Bradford	Y.	J. H. Cox.
Bradford-on-Avon	West	S. Howard.
Braintree	E.	H. H. Nankivell.
Branksome	West.	S. J. Newman.
Bray	I.	P. F. Comber.
Brecknock	W.	R. Davies.
Brentford	H.	N. Parr.
Bridgend	W.	M. Williams.
Bridgwater	West.	F. Parr.
Bridlington	Y.	J. F. Stow.
Brierfield	L. & C.	J. T. Landless.
Brierley Hill	M.	J. W. Beckley.
Brighton	H.	F. J. C. May.
Brisbane, Queensland	A.	T. Kirk.
Bristol	West.	T. H. Yabbicom.
Broadstairs	H.	H. Hurd.

TOWN.	DISTRICT.	NAME.
Bromley	H.	S. T. Hawkings.
Broughty Ferry, N.B	N.	D. Winning.
Brownhills	M.	J. H. Shaw.
Buckhurst Hill	E.	H. Tooley.
Buckingham	M.	J. Smith.
„ (County)	H.	R. J. Thomas
Bucklow (Rural)	L. & C.	J. McD. McKenzie.
Burnham	West.	W. J. Press.
Burnley	L. & C.	G. H. Pickles.
„ (Rural)	L. & C.	S. Edmondson.
Burslem	M.	F. Bettany.
Burton-on-Trent	M.	G. T. Lynam.
Bury	L. & C.	J. Cartwright.
Bury St. Edmunds	E.	J. C. Smith.
Buxton	M.	W. H. Grieves.
Caerphilly	W.	A. O Harpur.
Calverley	Y.	G. Riley.
Camberwell	Met.	W. Oxtoby.
Cannock, Staffs.	M.	H. M. Whitehead.
Canterbury	H.	A. Campbell.
Cape Town, S.A.	A.	R. O.Wynne-Roberts
Cardiff	W.	W Harpur.
„ (Rural)	W.	W Fraser.
Carlisle	N.	H. C. Marks.
Carlton	M.	R. Whitbread.
Carnarvonshire	W.	E. Evans.
Castleford	Y.	W. Green.
Castleton	L. & C.	R. J. Webster.
Cavan (County)	I.	R. N. Somerville.
Caversham	H.	W. R. Locke.
Chadderton	L. & C.	W. Eckersley.
Charlton	Met.	J. Rowland.
Chatham	H.	C. Day.
Cheadle	L. & C.	E. Sykes.
Chelmsford	E.	G. H. Sasse.
„ (Rural)	E.	I. C. Smith.
Chelsea	Met.	T. W. E. Higgens.
Cheltenham	West.	J. Hall.
Chepstow	W.	F. Feather.
Chesham	H.	A. H. Forbes.
Cheshire	L. & C.	H. F. Bull.
Cheshunt	H.	S. Towlson.
Chester	L. & C.	I. M. Jones.
Chesterfield	M.	H. E. Featherstone.
„ (Rural)	M.	T. A. Busbridge.
Chesterton	E.	J. Dunn.
Chichester	H.	J. Saunders.
Chorley	L. & C.	W. Leigh.
Church	L. & C.	W. E. Wood.
Clacton-on-Sea	E.	A. R. Robinson.
Clapham	Met.	A. Southam.
Clayton-le-Moors	L & C.	A. Dodgeon.
Claypole (Rural)	E.	C. D. M. Trinder.
Cleator Moor	N.	F. J. Edge.
Cleckheaton	Y.	C. Lund.
Cleethorpes	E.	E. Rushton.
Clevedon	West.	G. W. Knowles.
Clitheroe	L. & C.	J. E. Sharp.
Clown (Rural)	E.	W. T. Brown.
Coalville	M.	L. L. Baldwin.

TOWN.	DISTRICT.	NAME.
Cockermouth (Rural)	N.	J. B. Wilson.
Cockington	M.	J. C. Cowling.
Colchester	E.	H. Goodyear.
Colne	L. & C.	T. H. Hartley.
Colombo (Ceylon)	A.	R. Skelton.
Colwyn Bay	W.	W. Jones.
Congleton	L. & C.	R. Burslam.
Conway	W.	T. B Farrington.
Cookham (Rural)	H.	F. Laurens.
Cork	I.	H. A. Cutler.
„ (County), West	I.	N. Jackson.
Cork (County), South	I.	S. A. Kirkby.
„ „ East	I.	A. O. Lyons.
Cornwall (County), West	West.	T. J. Hickes.
Coseley	M.	C. W. Shackleton.
Coventry	M.	E. J. Purnell.
Cowpen	N.	R. Grieves.
Crewe	L. & C.	G. Eaton-Shore.
Cromer	E.	A. F. Scott.
Crompton	L. & C.	J. H. Mills.
Croydon	H.	T. Walker.
„	H.	E. F. Morgan.
Cumberland	N.	G. J. Bell.
Cupar (Fife)	N.	T. Aitken.
Dartford	H.	W. Harston.
Daventry	M.	J. B. Williams.
Darwen	L. & C.	R. W. Smith-Saville.
Deal	H.	T. C. Golder.
Denton	L. & C.	G. H. Newton.
Derby (County)	M.	J. S. Story.
Doncaster	Y.	W. H. R. Crabtree.
„ (Rural)	Y.	C. C. Barras.
Donegal (County) South	I.	R. W. F. Longfield.
Dorchester	West.	G. J. Hunt.
Dorking	H.	G. S. Mathews.
„ (Rural)	H.	W. Rapley.
Dover	H.	H. E. Stilgoe.
Down (County)	I.	P. C. Cowan.
Driffield (Rural)	Y.	T. C. Beaumont.
Droitwich	M.	T. P. Baylis.
Drumcondra	I.	M. Buckley.
Dublin	I.	S. Harty.
„ (County), South Division	I.	W. Collen.
Dudley	M.	J. Gammage.
Dukinfield	L. & C.	S. Hague.
Dumbartonshire	N.	A. Wilson.
Dunfermline (County)	N.	D. MacKenzie.
„	N.	A. W. Bell.
Durham (Rural)	N.	G. Gregson.
Ealing	H.	C. Jones.
East Barnet Valley	H.	H. York.
East Dereham	E.	H. G. Himson.
East Ham	H.	W. H. Savage.
Eastleigh	H.	W. Stringfellow.
East Molesey	H.	J. Stevenson.
East Stonehouse	West.	A. Debnam.
Eastbourne	H.	R. M. Gloyne.
East Retford (Rural)	M.	T. Henry.

TOWN.	DISTRICT.	NAME.
Ebbw Vale	W.	T. J. Thomas.
Eccles	L. & C.	A. C. Turley.
Edinburgh	N.	J. Cooper.
Elgin, N.B.	N.	A. A. Turriff.
Eltham	Met.	R. Findlay.
Enfield	H.	R. Collins.
Epsom	H.	E. R. Capon.
Erith	H.	H. Hind.
Eston	Y.	T. W. Stainthorpe.
Evesham	M.	R. C. Mawson.
Exeter	West.	D. Cameron.
Exmouth	West.	W. H. Beswick.
Falmouth	West.	W. H. Tressider.
Fareham	H.	W. Butler.
Farnborough	H.	R. W. Knapp.
Featherstone	Y.	W. A. Palliser.
Felixstowe	E.	G. S. Horton.
Fenny Stratford	H.	J. Chadwick.
Finchley	H.	A. Smythe.
Finedon	M.	A. Mosley.
Fleetwood	L. & C.	M. S. Gaulter.
Folkestone	H.	J. White.
Friern Barnet	H.	E. J. Reynolds.
Frodsham	L. & C.	W. Diggle.
Frome	West.	P. Edinger.
Fulham	Met.	C. Botterill.
Gainsborough	E.	H. Riley.
Galway (County), West	I.	J. Perry.
„ „ East	I.	J. Smith.
Gateshead-on-Tyne	N.	J. Bower.
Glamorgan	W.	T. L. Edwards.
Glasgow	N.	A. B. MacDonald.
Glastonbury	W.	G. Alves.
Gloucester	West.	R. Read.
„ (County)	West.	R. Phillips.
Glyncorrwg	W.	W. P. Jones.
Godalming	H.	J. H. Norris.
Godaveri, Madras	A.	P. H. Brown.
Gosforth	N.	C. J. Baff.
Gosport and Alverstoke	H.	H. Frost.
Grantham	E.	F. J. Morris.
Grays Thurrock	H.	A. C. James.
Great Crosby	L. & C.	W. Hall.
Great Grimsby	E.	M. Petree.
Great Yarmouth	E.	J. W. Cockrill.
Greenock	N.	A. J. Turnbull.
Grey Co., New Zealand	A.	J. Higgins.
Guildford (Rural)	H.	J. Dewhirst.
Hailsham	H.	J. Huxley.
Halesowen (Rural)	M.	B. Perrins.
Halifax	Y.	E. R. S. Escott.
„ (Rural)	Y.	F. Gordon.
Hammersmith	Met.	H. Mair.
Hampstead	Met.	C. H. Lowe.

TOWN.	DISTRICT.	NAME.
Hampton	H.	J. Kemp.
Hanley	M.	J. Lobley.
Hants (County)	H.	W. J. Taylor.
Hanwell	H.	S. W. J. Barnes.
Harrogate	Y.	S. Stead.
Harrow	H.	T. Charles.
Hartlepool	N.	H. C. Crummack.
Harwich	E.	H. Ditcham.
Haslingden	L. & C.	R. Taylor.
Haverhill	E.	T. Cockrill.
Heath Town	M.	J. H. Hanson.
Heaton Norris	L. & C.	W. C. Sheard.
Hebden Bridge	Y.	W. Calvert.
Heckmondwike	Y.	J. Saville.
Henlon	H.	S. S. Grimley.
„ (Rural)	H.	J. A. Webb.
Hengoed *viâ* Cardiff (Rural)	W.	J. Jones.
Henley-on-Thames	H.	R. Pratt.
Hereford	M.	J. Parker.
„ (County)	M.	H. T. Wakelam.
Herne Bay	H.	F. W. J. Palmer.
Hertford	H.	J. H. Jevons.
Heston and Isleworth	H.	W. A. Davies.
Heywood	L. & C.	J. A. Settle.
High Wycombe	H.	T. J. Rushbrooke.
Hinckley	M.	W. T. Howse.
Hindley	L. & C.	A. Holden.
Holborn	Met.	L. H. Isaacs.
Hong Kong	A.	F. A. Cooper.
Hornsea	Y.	P. Gaskell.
Hornsey	H.	E. J. Lovegrove.
Horsham	H.	R. Renwick.
Houghton-le-Spring	N.	V. Smith.
Hove	H.	H. H. Scott.
Hoylake and West Kirby	L. & C.	T. Foster.
Hoyland Nether	Y.	W. Farrington.
Huddersfield	Y.	K. F. Campbell.
Hull	Y.	A. E. White.
Hyde	L. & C.	J. Mitchell.
Islington (St. Mary)	Met.	J. P. Barber.
Ilford	E.	H. Shaw.
Ilfracombe	West.	O. M. Prouse.
Ilkeston	M.	H. J. Kilford.
Ipswich	E.	E. Buckham.
Irlam	L. & C.	W. R. Kay.
Isle of Ely (County)	E.	G. J. Moore.
Isle of Thanet (Rural)	H.	L. W. Hogbin.
Isle of Wight (County)	H.	F. Newman.
Itchen	H.	T. A. Collingwood.
Jarrow	N.	J. Petree.
Johannesburg, S.A.	A.	C. Aburrow.
Kearsley	L. & C.	T. Nuttall.
Keighley	Y.	W. H. Hopkinson.
Kendal	N.	D. C. Goddard.

TOWN.	DISTRICT.	NAME.
Kensington	Met.	W. Weaver.
Kent (County)	H.	F. W. Buck.
Keswick	N.	W. Hodgson.
Kettering	M.	T. R. Smith.
Keynsham (Rural)	West.	H. M. Bennett.
Kidderminster	M.	A. Comber.
Kildare (County)	I.	E. Glover.
Kilkenny	I.	A. M. Burden.
King's County	I.	R. B. Sanders.
Kingston-on-Thames (Rural)	H.	W. H. Hope.
„ „ (County)	H.	F. G. Howell.
Kingston, Jamaica	A.	C. V. Abrahams.
Kirkcaldy	N.	J. L. Lumsden.
Kirkleatham	Y.	J. Howcroft.
Kiveton Park (Rural)	Y.	W. Atkinson.
Kurachi	A.	J. Strachan.
Lambeth	Met.	J. P. Norrington.
Lancaster	L. & C.	J. Cook.
Lee	Met.	H. Woods.
Leeds	Y.	T. Hewson.
Leek	M.	J. Myatt.
Leicester	M.	E. G. Mawbey.
„	M.	F. Griffiths.
Leigh	L. & C.	T. Hunter.
Leintwardine	M.	H. W. Bowen.
Leith	N.	W. Beatson.
Leitrim	I.	E. O'N. Clark.
Levenshulme	L. & C.	J. Jephson.
Lewes	H.	D. Roberts.
Lewisham	Met.	J. Carline.
Leyton, E.	H.	W. Dawson.
Limerick (County)	I.	J. Horan.
Lincoln	E.	R. A. MacBrair.
Littleborough	L. & C.	G. H. Wild.
Littlehampton	H.	H. Howard.
Llandaff (Rural)	W.	J. Holden.
Llandudno	W.	E. P. Stephenson.
Llanelly	W.	G. Watkeys.
Llantrissant	W.	G. S. Morgan.
Loftus	Y.	T. H. Tarbit.
London (County)	Met.	Sir A. R. Binnie.
„ „	Met.	J. E. Worth.
Londonderry	I.	W. J. Robinson.
„	I.	J. Christie.
Longford (County)	I.	J. W. Gunnis.
Longton	M.	J. W. Wardle.
Loughborough	M.	G. Hodson.
Loughborough	M.	A. H. Walker.
Louth (County)	I.	P. J. Lynam.
Louth (Lincs.)	E.	T. Rowland.
Lowestoft	E.	G. H. Hamby.
Lurgan	I.	H. Shillington
Luton	H.	A. J. L. Evans.
Lymington	H.	I. Pym-Jones.
Macclesfield	L. & C.	E. E. Adshead.
„ (Rural)	L. & C.	J. Thorpe.
Madras	A.	R. L. Ellis.

TOWN.	DISTRICT.	NAME.
Maesteg	W.	J. Humphreys.
Maidstone	H.	T. F. Bunting.
„ (Rural)	H.	S. Stallard.
Maldon (Rural)	E.	H. G. Keywood.
Malton	H.	R. Richardson.
Malvern	M.	H. P. Maybury.
Manchester	L. & C.	T. De C. Meade.
Mansfield	M.	R. F. Vallance.
Mansfield Woodhouse	M.	F. P. Cook.
Margam, Port Talbot	W.	J. Cox.
Margate	H.	A. Latham.
Market Harborough	M.	H. G. Coales.
Matlock Bath	M.	W. Jaffrey.
Meath (County)	I.	J. H. Moore.
Melbourne	A.	W. Thwaites.
Melton Mowbray	M.	E. Jeeves.
Merthyr Tydvil	W.	T. F Harvey.
Methley	Y.	T. W. Nichols.
Mexborough	Y.	G. F. Carter.
Middlesbrough	Y.	F. Baker.
Middleton	L. & C.	W. Welburn.
Midsomer Norton	West.	W. F. Bird.
Mile End	Met.	J. M. Knight
Millom	N.	H. Waye.
Milton-next-Sittingbourne	H.	A. B. Acworth.
Mirfield	Y.	F. H. Hare.
Monaghan (County)	I.	J. Heron.
Monmouthshire (County)	W.	W. Tanner.
Montgomery	W.	W. P. Hole.
Morley	Y.	W. E. Putman.
Morpeth	N.	W. F. Curry.
Mossley	L. & C.	J. Haynes.
Mountain Ash	W.	J. Williams.

Neath (Rural)	W.	W. E. C. Thomas.
Nelson	L. & C.	B. Ball.
Neston	L. & C.	H. W. Corrie.
Newark	M.	G. Sheppard.
Newburn-on-Tyne	N.	T. Gregory.
Newbury	H.	S. J. L. Vincent.
Newcastle-on-Tyne	N.	W. G. Laws.
Newhaven	H.	F. J. Rayner.
New Malden	H.	T. L. Heward.
Newmarket	E.	J. W. Metcalf.
Newport, Mon.	West.	R. H. Haynes.
New Swindon	H.	H. J. Hamp.
Newton Abbott	West.	L. Stevens.
Newton-in-Makerfield	L. & C.	R. Brierley.
New Winchester (Rural)	H.	W. F. Y. Molineux.
North Bierley	Y.	P. Ross.
North Mayo (County)	I.	W. P. Orchard.
Northampton	M.	W. I. Brown.
„ (County)	M.	E. Law.
Northwich	L. & C.	J. Brooke.
Norwich	E.	A. E. Collins.
Nottingham	M.	A. Brown.
„ (County)	M.	E. P. Hooley.
Nuneaton	M.	J. S. Pickering.

TOWN.	DISTRICT.	NAME.
Ogmore and Garrw	W.	H. D. Williams.
Okehampton	West.	H. Geen.
Oldbury	M.	T. H. Shipton.
Oldham	L. & C.	S. A. Pickering.
Orrell	L. & C.	G. Heaton.
Otley	Y.	S. Trow.
Oundle	M.	J. M. Siddons.
Oxford	H.	W. H. White.
Oystermouth	W.	C. G. Bennett.
„	W.	J. Stansfield-Brun.
Paddington	Met.	G. Weston.
Padiham	L. & C.	J. Gregson.
Peebles (County)	N.	R. S. Anderson.
Pemberton	L. & C.	G. Heaton.
Penarth	W.	E. J. Evans.
Penmaenmawr	W.	E. Worrall.
Perry Barr	M.	H. H. Gammell.
Perth, N.B.	N.	R. McKillop.
Perth, West Australia	A.	T. C. Deverell.
Peterborough	M.	J. W. Walshaw.
Pietermaritzburg	A.	G. B. Laffan.
Plumstead	Met.	W. C. Gow.
Plymouth	West.	J. Paton.
Pokesdown	H.	E. W. Ingamells.
Pontardawe (Rural)	W.	J. Morgan.
Poole	West.	J. Elford.
Poplar	Met.	O. E. Winter.
Portslade-by-Sea	H.	A. T. Allen.
Portishead	West.	J. Moss Flower.
Portland	West.	E. J. Elford.
Portsmouth	H.	P. Murch.
Prescot	L. & C.	W. Goldsworth.
Pudsey	Y.	R. W. Cass.
Putney	Met.	J. C. Radford.
Queen's County	I.	H. V. White.
Radstock	West.	J. Martin.
Rangoon	A.	J. Stirrat.
Ramsbottom	L. & C.	T. Nuttall.
Raunds, Northamptonshire	N.	P. C. Dormer.
Rawmarsh	Y.	W. J. Petch.
Rawtenstall	L. & C.	A. W. Lawson.
Reigate	H.	W. H. Prescott.
Renfrew, N.B.	N.	A. R. Paterson.
Retford	M.	J. D. Kennedy.
Rhyl	W.	R. Hughes.
Richmond	H.	J. H. Brierley.
Richmond (Yorks.)	Y.	J. W. Wetherill.
Ripon	Y.	W. Edson.
Rochdale	L. & C.	S. S. Platt.
Rochester	H.	W. Banks.
Romford (Rural)	E.	E. G. Boden.
Roscommon	I.	C. J. Mulvany.
Rotherham	Y.	G. Jennings.
„ (Rural)	Y.	B. Godfrey.
Rotherhithe	Met.	N. Scorgie.
Rothwell, Northants	M.	W. T. Pearson.
Rowley Regis	M.	W. H. Brettell.

TOWN.	DISTRICT.	NAME.
Rugby	M.	D. G. MacDonald.
Rugeley	M.	W. E. Rogers.
Runcorn	L. & C.	J. Wilding.
Rushden	M.	W. B. Madin.
Ryde	H.	C. Mathew.
Ryton-on-Tyne	N.	J. P. Dalton.
St. Albans	H.	G. Ford.
St. George, Hanover Square	Met.	G. Livingstone.
St. Giles	Met.	G. Wallace.
St. Helen's	L. & C.	G. J. C. Broom.
„	L. & C.	J. Barton.
St. Martin-in-the-Fields	Met.	C. Mason.
St. Mary, Islington	Met.	J. P. Barber.
St. Pancras	Met.	W. N. Blair.
Saffron Walden	E.	G. W. Lacey.
Sale	L. & C.	A. G. McBeath.
Salford	L. & C.	J. Corbett.
Sandgate	H.	A. R. Bowles.
Sandwich	H.	A. J. Catt.
Sevenoaks	H.	J. Mann.
Shanghai, China	A.	C. Mayne.
Shanklin (Isle of Wight)	H.	E. C. Cooper.
Sheerness	H.	C. A. Copland.
Sheffield	Y.	C. F. Wike.
Sherborne	West.	T. Farrall.
Shifnal, Salop	M.	W. F. Y. Molineux.
Shildon	N.	W. A. Mason.
Shoreditch	Met.	J. R. Dixon.
Shrewsbury	M.	W. C. Eddowes.
Shropshire (County)	M.	A. T. Davis.
Singapore	A.	S. Tomlinson.
Skelton-in-Cleveland	Y.	W. P. Robinson.
Skipton	Y.	T. Mallinson.
„ (Rural)	Y.	A. Rodwell.
Sleaford	E.	J. Clare.
Sligo	I.	C. B. Jones.
Slough	H.	W. W. Cooper.
Smallthorne	M.	J. W. Deane.
Smethwick	M.	C. J. Fox-Allin.
Solihull (Rural)	M.	A. E. Currall.
South Hornsey	H.	M. W. Jameson.
South Mayo	I.	E. K. Dixon.
South Shields	N.	S. E. Burgess.
Southall Norwood	H.	H. R. Felkin.
Southampton	H.	W. B. G. Bennett.
Southgate	H.	C. G. Lawson.
Southowram	Y.	W. H. D. Horsfall.
Southport	L. & C.	R. P. Hirst.
Southwark, St. Olave	Met.	G. W. Thompson.
„ St. Saviour	Met.	G. R. Norrish.
Sowerby Bridge	Y.	F. Rothera.
Spalding (Rural)	E.	T. J. Peacock.
Spilsby	E.	F. J. Dixon.
Stafford	M.	W. Blackshaw.
Staffordshire	M.	J. Moneur.
Staines	H.	G. W. Manning.
Stamford	E.	J. Richardson.
Stockport	L. & C.	J. Atkinson.

TOWN.	DISTRICT.	NAME.
Stockport (Rural)	L. & C.	H. H. Turner.
Stoke (Rural)	M.	W. L. Sugden.
Stoke Newington	Met.	R. Brown.
Stone	M.	A. R. Ridout.
Stourbridge	M	W. Fiddian.
Strand	Met.	A. Ventris.
Stratford-on-Avon	M.	R. Dixon.
Streatham	Met.	H. J. Marten.
Stretford	M.	H. Royle.
Strood (Rural)	H.	W. Brooke.
Stroud	West.	G. P. Milnes.
Sudbury (Suffolk)	E.	L. W. A. Hayward.
Sunbury-on-Thames	H.	H. F. Coales.
Suffolk (County), East	E.	H. Miller.
Sunderland	N.	R. S. Rounthwaite.
Surrey (County)	H.	F. G. Howell.
Sussex (County), East	H.	H. Card.
Sutton	H.	C. C. Smith.
Sutton Coldfield	M.	C. F. Marston.
Sutton Coldfield	M.	W. H. Clarry.
Sutton-in-Ashfield	M.	McW. Bishop.
Swadlincote	M.	T. Kidd.
Swaffham	E.	C. R. W. Chapman.
Swanage	West.	J. S. Senior.
Swansea	W.	G. Bell.
„ (Rural)	W.	J. Thomas.
Swinton	L. & C.	H. Entwisle.
Sydney, N.S.W.	A.	R. W. Richards.
Tadcaster (Rural)	Y.	T. Scott.
Tamworth	M.	H. J. Clarson.
Tarvin (Rural)	L. & C.	H. T. Hughes.
Teddington	H.	M. Hainsworth.
Teignmouth	West	C. Jones.
Tenbury	M.	R. W. Jarvis.
Tettenhall	M.	J. Mortimer.
Thornhill	Y.	S. W. Parker.
Tientsin, China	A.	A.W.H. Bellingham.
Tipperary (County), South	I.	E. A. Hackett.
Tipton	M.	W. H. Jukes.
Todmorden	L. & C.	C R. Pease.
Tonbridge	H.	W. L. Bradley.
„	H.	A. F. Ginn.
„ (Rural)	H.	F. Harris.
Toowong, Queensland	A.	W. E. Irving.
Torquay	West.	W. Ingham.
Tokio Fu, Japan	A.	R. Hara.
„ „	A.	Y. Kurata.
Tottenham	H.	P. E. Murphy.
Tredegar	West.	W. C. Widdowson.
Trent Boulevard	M.	A. Smithies.
Trowbridge	West.	F. E. G. Bradshaw.
Tunbridge Wells	H.	T. E. W. Mellor.
Tunstall	M.	A. R. Wood.
Tyldesley	L. & C.	J. B. Smith.
Tynemouth	N.	J. F. Smillie.
Tyrone (County) North	I.	F. J. Lynam.
„ „ South	I.	J. W. Leebody.

TOWN.	DISTRICT.	NAME.
Upholland	L. & C.	C. E. Senior.
Urmston	L. & C.	C. C. Hooley.
Ventnor	H.	E. J. Harvey.
Wakefield	Y.	R. Porter.
„ (Rural)	Y.	F. Massie.
Wallasey	L. & C.	W. H. Travers.
Walsall	M.	R. H. Middleton.
„ (Rural)	N.	F. W. Mager.
Wallsend	N.	G. Hollings.
Walthamstow	H.	G. W. Holmes.
Walton-le-Dale	L. & C.	F. E. Dixon.
Wandsworth	Met.	P. Dodd.
Wanstead	H.	J. T. Bressey.
Wantage	H.	W. Hanson.
Ware	H.	J. Goddard.
Warwickshire (County)	M.	J. Willmot.
Warrnambool (Melbourne)	A.	J. C. Ross.
Waterford	I.	M. J. Fleming.
„ (County)	I.	W. E. L. Duffin.
Waterloo, Liverpool	L. & C.	F. S. Yates.
Watford	H.	D. Waterhouse.
„ (Rural)	H.	G. A. Heath.
Wath-upon-Dearne	Y.	H. C. Poole.
Wealdstone	H.	B. Wyand.
Wednesbury	M	E. M. Scott.
Wellingborough	M.	E. Sharman.
Wembley	H.	C. L. Whitehead, jun.
West Bridgford	M.	W. Pare.
West Bromwich	M.	A. D. Greatorex.
West Derby	L. & C.	F. C. Everett.
West Ham	H.	L. Angell.
West Hartlepool	N.	J. W. Brown.
West Malling (Rural)	H.	J. Marshall.
Westminster (St. James')	Met.	H. Monson.
Westminster (St. Margaret and St. John)	Met.	G. R. W. Wheeler.
Weston-super-Mare	West.	H. Nettleton.
Weymouth and Melcombe Regis	West.	W. B. Morgan
Whitechapel	Met.	J. A. P. Waddington.
Whitehaven	N.	J. S. Brodie.
Whitworth	L. & C.	F. Rodley.
Widnes	L. & C.	J. S. Sinclair.
Willenhall	M.	C. J. Jenkin.
Willesden	H.	O. C. Robson.
Wimbledon	H.	C. H. Cooper.
Windsor	H.	E. A. Stickland.
Wing and Eaton Bray (Rural)	H	J. McKenzie
Wirksworth	M.	D. J. Diver.
Wisbech	E.	A. H. Plowright.
Witham	H.	A. M. Clarke.
Withington	L. & C.	A. H. Mountain.
Witney	H.	G. A. Graham.
Wokingham	M.	J. Manley.
Wolverhampton	M.	J. W. Bradley.
Wood Green	H.	C. J. Gunyon.
Woodford	E.	J. E. Smales.

d

TOWN.	DISTRICT.	NAME.
WOOLLAHRA (Sydney)	A.	J. I. Haycroft.
WORCESTER	M.	T. Caink.
„ (County)	M.	J. H. Garrett.
WORTHING	H.	F. Roberts.
WORTLEY (Rural)	Y.	G. E. Beaumont.
WREXHAM	W.	J. W. M. Smith.
„ (Rural)	W.	J. P. Evans.
WYCOMBE (Rural)	M.	E. Birks.
YEOVIL	W.	W. K. L. Armytage.
YORK	Y.	A. Creer.
„ (Rural)	Y.	W. G. Penty.
YORKSHIRE (East Riding)	Y.	A. Beaumont.
YSTRADYFODWG	W.	W. J. Jones.

GRADUATES.

Adams, H. C.	City Surveyor's Office, Birmingham.
Andrews, L. P.	4 Lansdowne Road, Tottenham.
Angel, R. J.	Assistant Borough Surveyor, Town Hall, Walsall.
Ball, J. B., A.M. Inst. C.E.	8 The Sanctuary, S.W.
Bayley, G. H., A.M.Inst.C.E.	83 Brazenose Street, Manchester.
Beard, E. T.	Pevensey, Sussex.
Bentley, J. H., A.M.Inst.C.E.	31 Fern Street, Oldham.
Best, H. S.	7 Church Road, Beckenham.
Birch, J.	Public Offices, East Ham.
Bissell, W. S.	Borough Engineer's Office, Wolverhampton.
Blizard, J. H., A.M.Inst.C.E.	Lansdowne House, Southampton.
Bowe, D. J.	Town Hall, Eastbourne.
Bradshaw, J.B., A.M.Inst.C.E.	Headquarters, R. E. Office, Bermuda.
Briscoe, J. T.	Laurel Dene, Southbury Road, Enfield.
Bruce, W.	Borough Engineer's Office, Edinburgh.
Bryans, J. G.	Assistant Engineer, Buenos Ayres and Pacific Railway, Junin, Argentine.
Bryning, W. G.	Higher Bank Road, Fulwood, Preston.
Burton, A., A.M. Inst. C.E.	Town Hall, Hanley.
Carter, G. F., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Cartledge, J. R.	Assistant Surveyor, District Council, Barnes.
Catchpole, J. H.	27 Avenue Villas, Avenue Road, Finchley, N.
Chasemore, A. E.	98 High Street, Putney.
Claypoole, A. H., A. M. Inst. C.E.	City Engineer's Office, Bristol.
Clegg, H.	City Engineer's Office, Sheffield.
Collis-Adamson, A. C.	Northgate House, Highgate, N.
Cook, F. C.	Council Offices, Nuneaton.
Creswell, W. T.	12 Dartmouth Steeet, Westminster.
Cross, F. W., A.M. Inst. C.E.	The Bridge, Walsall.
Crow, A.	51 Great Prescot Street, E.
Cudbird, T. O.	The Refuge, Caernarvon Road, Norwich.
Dent, J. P.	24 Lomeshaye Road, Nelson, Lancashire.
Dickinson, A. J.	Town Hall, Sheffield.
Dolamore, F.	Borough Engineer's Office, Bournemouth.
Endsor, H. A.	10 Catton Grove Villas, Old Catton, Norwich.
Farnham, W. A.	Surveyor to the Urban District Council, Milton-next-Sittingbourne.
Fell, P. O.	City Engineer's Office, Norwich.
Fenton, W. C.	10 Paradise Square, Sheffield.
Finch, A. R., A.M. Inst. C.E.	Town Hall, Kensington.
Finch, L. E.	Town Hall, Bermondsey.
Finglah, F. J.	Town Hall, Hounslow.
Fox, Senior L.	Soothill Hall, near Batley.
Franck-Clark, A. H.	District Engineer, P.W.D., Ratnapura, Ceylon.
Fraser, R. W.	Town Hall, Wolverhampton.
Gibbs, L., Assoc. M. Inst. C.E.	Surveyor's Office, P.W.D., Hong Kong.
Glass, S. N.	16 Ravenscroft Road, Chiswick.
Godfrey, C. H.	Town Hall, Manchester.

Gordon, J., A.M. Inst. C.E.	Assistant Burgh Surveyor, Town House, Aberdeen.
Grant, F. T.	Assistant Borough Surveyor, Maidstone.
Greenwood, J. P.	Town Hall, Burnley.
Grimley, F. C.	R.E. Office, Colchester.
Haigh, W. H.	Borough Engineer's Office, Cardiff.
Harding, W. D.	Surveyor to the Urban District Council, Exmouth.
Hellawell, O.	Town Hall, Withington, Manchester.
Hendry, J. S.	Town Hall, West Bromwich.
Hills, H. J., A M. Inst. C.E.	21 Gloucester Road, Philip Lane, Tottenham.
Hills, O. C.	147 Bow Road, E.
Horne, B.	"Greenfields," Rhayader.
Houghton, J	King's Heath, Birmingham.
Jeffes, R. H.	Brabant Villa, Portsmouth Road, Thames Ditton.
Jenkins, A. J., A.M.Inst.C.E.	Town Hall, Cardiff.
Jenkins, R. J.	49 Queen's Road, Portsmouth.
Johnston, R. W.	Borough Surveyor's Office, Birkenhead.
Julian, J.	Borough Surveyor's Office, Cambridge.
Kieser, W. H. G.	Town Hall, Torquay.
Killick, W. H.	Borough Surveyor's Office, Southampton.
Kirk, J. W.	Town Hall, Westminster.
Liversedge, J. W.	Surveyor to the Urban District Council, Ashton-in-Makerfield.
Lobley, F. J.	Council Offices, Ealing.
Marks, C. W.	Clarence Road, Newport, Isle of Wight.
Martin, E. B., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Maxwell, W. H.	Assistant Engineer, Town Hall, Leyton.
Newton, E. B.	Vestry Hall, Harrow Road, W.
Nichols, A. E., A.M.Inst.C.E.	City Engineer's Office, Leeds.
Nightingale, C. F.	36 Bradford Street, Walsall.
Oakden, R.	Surveyor to the Rural District Council, Newark.
Openshaw, J., A.M.Inst.C.E.	Borough Engineer's Office, Salford.
Parr, F. H.	Council Offices, Mortlake.
Perkins, J.	85 Willows Road, Balsall Heath, Birmingham.
Perkins, T. L.	51 Prince Street, Bristol.
Price, A. J.	City Engineer's Office, Worcester.
Pritchard, T., A M.Inst.C.E.	264 Gresham House, Old Broad Street, E.C.
Quick, A. H.	15 Fernholme Road, Newlands, S.E.
Redfern, J. L.	Deputy City Engineer, Carlisle.
Savage, E. B., A.M.Inst. C.E.	City Engineer's Office, Norwich.
Smith, G. H.	"Brookelands," New Malden, Surrey.
Spink, J.	City Surveyor's Office, Manchester.
Steele, W. J.	Deputy City Engineer, Bristol.
Sutton, W. F.	42 Duchess Road, Edgbaston, Birmingham.
Thackeray, F.	43 Richmond Terrace, Darwen.
Tiffin, T. E.	York Road, West Hartlepool.
Veit, L. J.	Town Hall, Barrow-in-Furness.
Videan, H. N.	Assistant Borough Surveyor, Folkestone.
Ward, F. D., A. M. Inst. C.E.	38 High Street, Welshpool.
Warren, A. R.	73 Breakspears Road, St. Johns, S.E.
Webb, F.	Town Hall, Chelsea.
Wells, F. B.	1 Victoria Square, Coatham, Bristol.
Williams, D. S.	Town Hall, Mountain Ash.
Willis, E.	Public Offices, Dyne Road, Kilburn, N.W.
Wilson, F.	9 Barnsbury Square, London. N.
Worrall, F., A. M. Inst. C.E.	Surveyor to the Urban District Council, Long Eaton.
Wright, J. A.	Lonsdale Chambers, Baldwin Street, Bristol.
Yarwood, Hy.	Town Hall, Rochdale.
Young, W.	Town Hall, Salford.

PARLIAMENTARY AND GENERAL PURPOSES COMMITTEE.

W. WEAVER, *Chairman.*

LEWIS ANGELL (West Ham).
J. P. BARBER (Islington).
CHAS. JONES (Ealing).
C. H. LOWE (Hampstead).
O. C. ROBSON (Willesden).
T. WALKER (Croydon).

FINANCE COMMITTEE.

W. WEAVER, *Chairman.*

J. P. BARBER (Islington).
W. HARPUR (Cardiff).
J. S. PICKERING (Nuneaton).
C. JONES (Ealing).
T. H. YABBICOM (Bristol).

BYE-LAWS.

MEMBERSHIP.

1. Members, Graduates, and Honorary Members of the existing Association may, upon signing and forwarding to the Secretary a claim according to Form F in the Appendix, become Members, Graduates, or Honorary Members respectively of the Association, without election or payment of entrance fees.

MEMBERS.

2. Candidates for admission as Members must be Civil Engineers or Surveyors holding chief permanent appointments under any Municipal Corporations, County Councils, or Urban or Rural Sanitary Authorities, and Civil Engineers or Surveyors holding other chief permanent appointments under any Public Authority of the like nature within the United Kingdom, or in the Colonies or foreign countries.

GRADUATES.

3. Candidates for admission as Graduates must be successful in obtaining certificates of competency at any examination under the auspices of the Association, and who are not otherwise qualified as Members of the Association; and as such shall be entitled to attend the General and District Meetings, and to take part in the proceedings thereof, and be entitled to a copy of the Minutes of Proceedings, but shall not be entitled to vote. Graduates shall at their request become Members of the Association when qualified according to Bye-law 2.

HONORARY MEMBERS.

4. The Council shall have the power to elect as Honorary Members gentlemen of eminent scientific position or acquirements, who in their opinion are eligible for that position.

5. The Members, Graduates, and Honorary Members shall have notice of and the privilege to attend all Meetings, and be entitled to a copy of the Proceedings of the Association as published.

ENTRANCE FEES AND SUBSCRIPTIONS.

6. An Entrance Fee of One Guinea shall be paid by each Member, except Members of the existing Association, who shall pay no Entrance Fee. Each Member shall pay an Annual Subscription of One Guinea.

7. A Graduate shall not be required to pay an Entrance Fee, either on his becoming a Graduate or on his becoming a Member. Each Graduate shall pay an Annual Subscription of Half a Guinea.

8. All Subscriptions shall be payable in advance, and shall become due on the 1st day of May in each year; and Members elected between the 1st day of January and the 1st day of May in each year are required to pay an Entrance Fee on Election, their first Subscription being due on the 1st day of May following their Election.

9. The Council may at their discretion reduce or remit the Annual Subscription, or the Arrears of Annual Subscription, of any Member who shall have been a Subscribing Member of the Association for ten years, and shall have become unable to continue the Annual Subscription provided by these Bye-laws.

10. No Proceedings or Ballot Lists shall be sent to Members or Graduates who are in arrear with their Subscriptions more than twelve months, and whose Subscriptions shall not have been remitted by the Council as hereinbefore provided.

ELECTION OF MEMBERS AND GRADUATES.

11. A recommendation for admission according to Form A for a Member, and Form B for a Graduate, in the Appendix, shall be forwarded to the Secretary, and by him be laid before the next Meeting of the Council.

The recommendation must be signed by not less than Two Members, who from personal knowledge of such Candidate shall certify that he possesses the necessary qualification. Candidates residing outside England and Wales not known by two Members of this Association, may be proposed by three Corporate Members of the Institution of Civil Engineers. Members who cease to hold their appointments are eligible for re-election by the Council, but will be disqualified from holding any Office.

All Elections of Members and Graduates of the Association shall be made by the Council, and shall be decided by a majority of votes of the Members of the Council present and voting.

12. When the proposed Candidate is elected, the Secretary shall give him notice thereof according to Form C; but his name shall not be added to the List of Members or Graduates of the Association until he shall have paid his Entrance Fee and First Annual Subscription as defined by these Bye-laws.

13. A qualified Graduate desirous of becoming a Member shall forward to the Secretary a recommendation according to Form D in the Appendix, signed by not less than two Members, which shall be laid before the next meeting of the Council for their approval. On their approval being given, the Secretary shall notify the same to the Candidate according to Form E. A Graduate on becoming qualified to be a Member shall cease to be a Graduate.

ELECTION OF PRESIDENT, VICE-PRESIDENTS, AND MEMBERS OF COUNCIL.

14. The Council shall nominate one name for President, six for Vice-Presidents, one for Honorary Secretary, and fifteen for Ordinary Members of Council. In addition to these, each Member of the Association shall be at liberty to nominate one Member for the Council, but in the event of the last named nominations exceeding fifteen, the Council shall reduce them to that number, so as to leave thirty names in all from which to elect the required number of Ordinary Members of Council. Members' nominations must be in the hands of the Secretary on or before the 20th of April in each year. And in case the Members' nominations should not reach fifteen, the Council shall have the power to make up the total number of nominations to twenty. Such list of twenty nominations shall be printed and sent to each Member of the Association not less than fourteen days previous to the Annual Meeting. Each Member shall be entitled to vote for or erase any of such Nominations or substitute other names, subject in all cases to the limits of Clause 25 in the Articles of Association, and return the same within seven days from the date of issue. Such Ballot Papers shall be examined in London by the President, Secretaries, and two Scrutineers appointed at the

previous Annual Meeting, or by any two of the aforesaid Members. Any Member canvassing for votes for the office of Member of Council shall be considered ineligible for Election.

APPOINTMENT AND DUTIES OF OFFICERS.

15. The Treasurer shall hold the uninvested funds of the Association, except the moneys in the hands of the Secretary for current expenses. He shall be appointed by the Members at a General or Special Meeting, and shall hold office at the pleasure of the Council.

16. The Secretary of the Association shall be appointed by the Council, and shall be removable by the Council upon three months' notice from any day. The Secretary, if desirous of resigning his appointment, shall give the same notice. The remuneration of the Secretary shall from time to time be fixed by the Council.

17. It shall be the duty of the Secretary, under the direction of the Council, to conduct the correspondence of the Association; to attend all General and Special Meetings of the Association and of the Council, and of Committees (but not the District Meetings, unless required so to do by the President); to take minutes of the proceedings of such meetings; to read the minutes of the preceding meetings, and all communications that he may be ordered to read; to superintend the publication of such papers as the Council may direct; to direct the collection of the subscriptions, and the preparation of the account of expenditure of the funds; and to present all accounts to the Council for inspection and approval, and generally to do all such other matters as usually pertain to the office of Secretary, or as may be prescribed by the Council.

EXAMINATIONS.

18. Two or more examinations of Candidates for certificates of competency in Municipal Engineering, Surveying, Building Construction, Sanitary Science and Municipal Law, shall be held annually at such places and at such times as the Council shall appoint.

The Board of Examiners shall be not less than twelve in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the Engineering profession. Four or more of such Board shall be selected by the Council to carry out each Examination, who as "Acting Examiners" shall report to the Council the names of those Candidates who have satisfied them of their proficiency.

MISCELLANEOUS.

19. All communications to the meetings shall be the property of the Association, and be published only by the authority of the Council.

20. Seven clear days' notice at least shall be given of every meeting of the Council. Such notice shall specify generally the business to be transacted by the meeting.

21. The Council shall present the yearly accounts to the Members at the Annual General Meeting, after being audited by two auditors, who shall be appointed annually by the Members at their Annual General Meeting.

THE
INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

TWENTY-FIFTH ANNUAL MEETING.

EDINBURGH, *June* 30, *July* 1 *and* 2, 1898.

THE Members assembled in the Council Chamber, City Chambers, where they were received by the Right Hon. Mitchell Thomson, Lord Provost of Edinburgh, who very warmly welcomed the Association to Edinburgh.

Mr. Lewis Angell, Past-President, in the absence of Sir Alexander Binnie, whose public work prevented his attendance, expressed thanks for the cordial reception which had been accorded to the Members.

The Members then adjourned to the Yellow Room at the Royal Hotel, when Mr. Lewis Angell took the chair, and the minutes of the Annual Meeting held in London in July 1897 were read, confirmed and signed.

The Secretary then read the Council's Annual Report for the year ending April 30th, 1898.

ANNUAL REPORT.

In presenting the twenty-fifth Annual Report, the Council are gratified to state that the progress of the Association during the past year has been satisfactorily maintained.

DISTRICT MEETINGS.

Since the last Annual General Meeting, six District Meetings have been held. At Rhayader, for the Birminghan Waterworks, August 28th, 1897; Sunderland, November 20th;

Westminster, February 18th, 1898; Wimbledon, April 30th; Harrogate, for the Bradford Waterworks, June 4th; Norwich and Great Yarmouth, June 10th and 11th.

THE ROLL OF THE ASSOCIATION.

During the financial year ending on April 30th last, 72 new Members, consisting of 54 Ordinary Members and 18 Graduates, have joined the Association. One new Honorary Member, Monsieur Bechmann, Chief Engineer of Ponts et Chaussés, Paris, has been elected. Six Members and one Graduate have resigned. Sixteen names have been written off, and the Council record with regret the deaths of Messrs. D. Bland, T. Higginson, D. G. Ottley, E. Rothwell, J. C. Stuart and W. S. Till. The number on the roll of the Association at the close of the year was 10 Honorary Members, 732 Ordinary Members, and 92 Graduates, making a total of 834, being an addition equal to 5·4 per cent. on the numbers of the preceding year. The Council have transferred Messrs. G. Ball, H. W. Corrie, T. Hayward, C. T. Lynam, and J. A. Settle from the class of Graduates to that of Members, these gentlemen having been elected to appointments qualifying them for this class under the Articles of Association. The Council have also to place on record with deep regret the death of Sir Robert Rawlinson, K.C.B., who has been an Honorary Member of this Association since its formation. Sir Robert Rawlinson, who was Chief Inspector of the Local Government Board for many years, always showed a deep sympathy with, and a keen interest in, the work of this Association.

THE FINANCES.

The audited Balance Sheet and Statement of Accounts which accompanies this Report shows a balance in hand on April 30th last of 255*l.* The invested capital account of the Association now stands at 750*l.* 7*s.* 4*d.*, 250*l.* having been invested to purchase 260*l.* 7*s.* 4*d.* India 2½ per cent. Stock, during the year. The statement of assets and liabilities shows the Association to be in a highly satisfactory position.

EXAMINATIONS.

A marked and gratifying increase is shown in this department of the Association's work.

Since the last Report two examinations have been carried out, the first of which was held at the Council House, Birmingham, on October 1st and 2nd, 1897. On this occassion 20 candidates were examined; 11 satisfied the examiners and were granted the Association's certificate. The examiners were Messrs. Pritchard, Fowler, Lemon and Eayrs. The second examination was held on April 1st and 2nd, 1898, at the Institution of Civil Engineers, Westminster, where the use of rooms was kindly granted by the Council of that body. On this occasion 46 candidates were examined, of whom 30 satisfied the examiners and were granted the Association's certificate. The examiners were Messrs. Fowler, Lemon, Lobley, May and Jones.

Arising out of the great increase of candidates for examination, the Council have had under consideration a report from the Board of Examiners submitting certain recommendations for the conduct of future examinations, and have approved such report. To give effect to the same, the Council recommend the alteration of Bye-law 18, so as to give power to the Council to enlarge the Board of Examiners and the number of examinations. The required alterations are set forth in the agenda notice of this meeting.

THE NEW COUNCIL.

The ballot lists having been duly issued, the Scrutineers reported the result of the voting as follows:—

President—O. Claude Robson.

Vice-Presidents—J. Cooper, W. Harpur, C. H. Lowe.

Ordinary Members of Council—J. P. Barber, A. E. Collins, J. H. Cox, A. Creer, A. T. Davis, E. P. Hooley, E. G. Mawbey, J. Paton, S. S. Platt, J. Price, W. Weaver, T. H. Yabbicom.

General Honorary Secretary—Chas. Jones.

Treasurer—Lewis Angell.

PREMIUMS.

The Council have awarded the Association's premium of books, value 10*l.*, to Mr. S. S. Platt, for his paper entitled "Some of the Municipal Works at Rochdale"; and the premium of books, value 5*l.*, to Mr. W. Blackshaw, for his paper entitled "Particulars of some Municipal Engineering Works designed and carried out at Stafford."

SUPERANNUATION.

A considerable amount of attention has been given by the Council and its committees to the subject of superannuation, arising out of the consideration of three Bills now before Parliament. The Bills referred to are: (1) The Metropolitan Local Government Officers' Superannuation Amendment Bill; (2) The Local Authorities Officers' Superannuation Bill; and (3) The Local Government Ireland Bill.

With regard to the two first-mentioned Bills, the Council took all available means, by memorials and circulars, to advance the measures and to protect the interests of the Members of the Association. In response to such efforts the Council have received numerous promises of support from Members of Parliament, and the Local Government Board have also promised to support the suggested scheme for superannuation so soon as they receive satisfactory assurance that the measures meet with the approval of the bulk of the Local Authorities affected by the Bills. With reference to the third of the above-named Bills, the Council have had conference with representatives of the County Surveyors of Ireland, and received from them a statement of their wishes as to alterations in the Bill necessary for the protection of their interests, and in the result the measure has been materially amended on the lines desired by the Irish Members of the Association, and the Council experience considerable gratification in recording the assistance thus afforded to their brethren across the Channel.

CORRESPONDING SECRETARY.

The Council have appointed Mr. R. W. Richards, the City Surveyor of Sydney, Corresponding Secretary for Australasia. Mr. Richards having evinced so strong an interest in the Association, the Council believe the appointment made will tend to benefit the Association, and to bring its advantages under the notice of many eligible officials in our Australian Colonies.

LOCAL GOVERNMENT BOARD JOINT EXAMINATIONS.

With respect to the Joint Committee on the question of the examination of sanitary inspectors, instituted by the Local Government Board, the Council are pleased to report that satisfactory arrangements have lately been made by which the difficulties met with by the Committee have been surmounted, and that shortly the final steps will be taken for the incorporation of the body thus formed.

CHAS. JONES, *Hon. Secretary.*
THOMAS COLE, *Secretary.*

On the motion of the Chairman, seconded by Mr. W. G. Laws, the Report was received and adopted.

The Chairman then presented the Association's first premium of 10*l.* in books to Mr. S. S. Platt for his paper on "Some of the Municipal Works at Rochdale," and the second premium of 5*l.* in books to Mr. W. Blackshaw for his paper entitled "Particulars of some Municipal Engineering Works designed and carried out at Stafford."

It was proposed by the Chairman, duly seconded and carried that Bye-law 18 be altered to read as follows:—

"Two (*or more*) examinations of candidates for certificates of competency in municipal engineering, surveying, building construction, sanitary science and municipal law, shall be held annually at such places and at such times as the Council shall appoint.

"The board of examiners shall be (*not less than*) twelve in number, and shall be elected by and be Members of the Council, or such other Members of the Association as shall be leading men in their particular branch of the profession. Four (*or more*) of such board shall be selected by the Council to carry out each examination, who, as 'acting examiners,' shall report to the Council the names of those candidates who have satisfied them of their proficiency."

On the motion of the Chairman, seconded by Mr. Lemon, the various District Secretaries were re-elected pending meetings in their several districts.

Mr. T. L. Lewis (St. George, Bristol) and Mr. W. H. Savage (East Ham) were unanimously re-elected Auditors for the ensuing year.

Messrs. H. J. Clarson, E. J. Silcock and R. J. Thomas were unanimously re-elected Scrutineers for the ensuing year.

Mr. Angell then introduced the President elect, and vacated the chair in favour of Mr. O. C. Robson.

Mr. Angell moved, and Mr. Lobley seconded, that a vote of thanks be awarded to Sir Alexander Binnie, the retiring President, both expressing regret that the onerous nature of Sir Alexander's duties had prevented his attendance.

Mr. Robson read his Inaugural Address,* a hearty vote of thanks for which was proposed by Mr. C. Jones, seconded by Mr. Barber, and carried unanimously.

The following papers were read and discussed:—

"Use of Tarred Macadam in the Construction of Roadways in Urban Districts." By A. H. Campbell.

"Working of the Housing of the Working Classes Act (1890) in Edinburgh." By W. Bruce.

"Experience of Edinburgh with Refuse Destructors." By J. Young.

"Conversion of Edinburgh, Leith and Portobello Horse Tramways into Cable Traction." By W. N. Colam.

"Notes on Sewer Ventilation as applied to Water of Leith Intercepting Sewer." By A. Stewart.

---

* This address and the papers read at the Meeting will be found at the end of the volume.

"Notes on Bacterial Treatment of Sewage," By D. Cameron.

"A Two Hours' Test of a Steam Ram Pumping Plant." By J. B. Wilson.

"The Electric Lighting of Edinburgh." By F. A. Newington.

"Notes on Leith Docks and New Works now in Progress." By P. Whyte.

Votes of thanks to the Authors of the papers were carried unanimously.

Dr. STATEMENT OF RECEIPTS AND EXPENDITURE

RECEIPTS.		£	s.	d.
To Balance at Bank, May 1, 1897		411	2	3
„ Balance of Petty Cash from last Account		1	11	8
„ Entrance Fees		44	2	0
„ Subscriptions		666	5	3
„ New Graduates		9	9	0
„ Subscriptions in advance		8	8	0
„ Arrears		47	15	6
„ Sale of 'Proceedings'		21	13	2
„ Examination Fees		202	2	6
„ Interest on Stock		18	3	1
„ Balance of Petty Cash due to Secretary		2	17	7
	£	1433	10	0

STATEMENT OF ASSETS

LIABILITIES.		£	s.	d.
To Estimated Liability on Vol. XXIV.		40	0	0
„ Sundry Printing, Stationery, &c.		30	0	0
„ Reporting		6	6	0
„ Sundry Creditors		15	14	0
„ Balance Petty Cash due to Secretary		2	17	7
„ Balance		1122	9	11
	£	1217	7	6

Examined and found correct, this

OR THE YEAR ENDING APRIL 30, 1898. Cr.

EXPENDITURE.	£	s.	d.	£	s.	d.
By Reports of Meetings		..		42	0	0
„ Examiners' Fees and Expenses		..		60	10	5
„ Auditors		..		3	3	0
„ Secretary's Salary and Rent		..		250	0	0
„ Allowance for Assistant		..		58	0	0
„ Meeting Expenses		..		24	7	2
„ Messrs. Clowes, Vol. XXIII. and other printing		..		278	12	6
„ Printing, Stationery		..		62	12	7
„ Messrs. Sprague and Co., Illustrations		..		21	13	0
„ Scrutineers' Expenses		..		5	9	6
„ Rent of Telephone		..		17	0	0
„ Purchase of 260*l.* 7*s.* 4*d.* India 2½ per cent. Stock		..		250	0	0
„ Sundries, Office Furniture		..		4	14	0
„ Travelling Expenses		..		24	18	2
„ Banker's Charges		..		1	0	5
„ Petty Cash—						
Postages	44	17	5			
General	29	11	10			
				74	9	3
„ Balance at Bank, May 1, 1898		..		255	0	0
			£	1438	10	0

ND LIABILITIES.

ASSETS.	£	s.	d.	£	s.	d.
By Balance at Bank		..		255	0	0
„ £490 Southampton Corporation Stock		..		529	4	0
„ £260 7*s.* 4*d.* India 2½ per cent Stock		..		250	0	0
„ Subscriptions in Arrear	154	7	0			
less 50 per cent. bad	77	3	6			
				77	3	6
„ 'Proceedings' in Stock	209	0	0			
less 60 per cent.	125	0	0			
				84	0	0
„ Office Furniture		..		22	0	0
			£	1217	7	6

th *day of May*, 1898.

T. Lawrence Lewis, } *Auditors.*
W. H. Savage, }

Lewis Angell, *Treasurer.*
Chas. Jones, *Hon. Secretary.*
Thomas Cole, *Secretary.*

DISTRICT MEETING AT RHAYADER.

VISIT TO THE ELAN VALLEY.

August 28, 1897.

SIR ALEXANDER BINNIE, M. INST. C.E., *President.*

ON arrival at the works the Members were received by Mr. James Mansergh, C.E., who was accompanied by Sir Alexander Binnie, President of the Association, Mr. John Price, C.E., City Engineer of Birmingham, and several of Mr. Mansergh's engineering assistants, including the resident engineer.

The party, under the guidance of Mr. Mansergh and his staff, immediately descended into the conduit, the first section of which is being constructed by Messrs. John Aird and Sons, and were thus afforded an opportunity of inspecting a section of the cut and cover work. Inside the conduit Messrs. Aird and Sons had thoughtfully provided some light refreshments, which were thoroughly enjoyed after the somewhat tiring railway journey from Shrewsbury. Emerging from the cut and cover conduit, Mr. Mansergh briefly sketched an itinerary for the day's inspection of the extensive works. Mr. Mansergh informed his visitors that the point at which they were assembled was about seventy miles distant from the service reservoirs at Frankley, which would hold 200 million gallons, and was 600 feet above Ordnance datum. The fall of the conduit is 1 in 4000, and this is also the fall of the Crag-y-Foel tunnel, the Downfield tunnel immediately beyond Rhayader, the Fron tunnel at Penybont, two short tunnels in the old red sandstone between Ludlow and Cleobury Mortimer, the Horspool tunnel near Halesowen and the Frankley tunnel at the reservoir. The gradients of those portions of the aqueduct in syphon will be 1 in 1760, with the exception of the Tame syphon and the long Severn and Slour syphon, in which the gradient is 1 in 1600. The aqueduct was being constructed by contract, in sections of about ten miles each, the first section being carried out by Messrs. Aird, and the second section by Messrs. Morrison and Mason. The total water product of the area might be taken as 100 million to 125 million gallons per day. Under the Birmingham Water Act they would have to send into the river as compensation water 27 million gallons a day. The present flow of the river had been gauged at 4,500,000 gallons a day, so that the compensation water to be provided would increase the flow six times over. They were providing storage for 18,000 million gallons. The party would travel over the railway which had been constructed along the valley of the Elan, and opportunity would be given of seeing the extensive workshops which had been erected in the vicinity of the Caban dam.

Describing the points of interest to be observed during the railway ride through the Elan valleys, Mr. Mansergh stated that the Baptist chapel and graveyard, which would be observed to their left hand, had to be built to replace a chapel which had to be submerged. They had also to remove the few bodies interred there to the new graveyard. A police station had also been erected, but he was pleased to say there had so far been little or nothing for the policeman to do. Next came the stables, and then they would proceed along the site of Caban Coch reservoir until they reached the Pen-y-Gareg dam, near to which they had built the village, which would accommodate considerably over 1000 persons. High on the right would be seen the infectious diseases hospital, for which, happily, there had been little or no requirement. Then came the doss house, in which all strangers applying for work were required to spend a night before going into the village—on going into the doss house they had a bath, their clothes were disinfected, and they were provided with a comfortable bed.

Mr. Mansergh then had distributed among the Members the following description of the chief engineering details of the works, together with detailed drawings of the watershed area and the line of conduit from Rhayader to Birmingham.

BIRMINGHAM CORPORATION WATER. ELAN SUPPLY.

The plan shows the watershed secured under the Act of 1892. Its area is 45,562 acres, or 71 square miles.

The scale of the plan is about 2¼ miles to a lineal inch, and the shed is 12½ miles long from north to south, and 8½ from west to east.

The elevation above Ordnance datum, or mean sea level of the bed of the river at the site of the lowest dam, that is the Caban, is 700 feet.

At various points the lip of the basin rises to the following elevations, beginning at the south-east corner and going round with the sun, viz.: S.E.; 1919, 2019, 2120, S.W.; 1827, 1725, 1949 W.; 1873, 1638 N.; 1718, 1752 E.; and 1582 just north of the Caban dam.

The sections along the Elan and Claerwen valleys show their respective reservoirs coloured blue, the vertical scale being about 600 feet to an inch, and the horizontal the same as the plan; those coloured brown are cross sections of the valleys at each of the dam sites on a natural scale of 600 feet to an inch.

The mean annual rainfall on the whole shed is about 68 inches.

Six reservoirs are to be constructed to impound the waters flowing off by the rivers, their aggregate capacity being nearly 18,000 millions of gallons. On the Elan they are the Caban (which also occupies the lower part of the Claerwen Valley), the Pen-y-Gareg and the Craig-Gôch; on the Claerwen the Dol-y-Mynach, the Cil Oerwynt, and the Pant-y-Beddau.

Top water of the first named is to be 822 feet above Ordnance datum, and of the last, 1175 feet. The others are at intermediate elevations.

The dams of these reservoirs will all be built of masonry, and will vary from 98 to 128 feet in height above the beds of the rivers.

To provide the first instalment of 27 million gallons a day to Birmingham and the 27 millions of compensation water to the river, the Caban, Pen-y-Gareg and Craig-Gôch reservoirs will have to be constructed.

The storage capacity of the reservoirs will be as follows, in million gallons: Caban Coch, 7540; Pen-y-Gareg, 1320; Craig-yr-Allt Gôch, 2000; Dol-y-Mynach, 1500; Cil Oerwynt, 3100; and Pant-y-Beddau, 1900. The top water area of the reservoirs taken in the same order will be 479, 124, 217, 184, 269 and 244. The top water heights above the sea will be 820, 945, 1040, 900, 1095 and 1175 feet respectively.

The Members, having been supplied with the plans and drawings, proceeded at the outset to view the plan adopted of carrying the water across the deeper valleys by means of iron pipes. The engineer has constructed an air valve at one of the highest points of the pipes to allow of the escape of any imprisoned air from the syphon, which might otherwise interfere with the water flow. These air valves are to be found at the summit of all the syphons, while wash-out valves have been put in at sharp depressions in the line to ensure the removal of any earthy matter carried down by the water. The Caethon inlet chamber, the construction of which was nearly completed at the time of the visit, was inspected with much interest. The chamber contains six iron valves to regulate the admission of the water flow to the six lines of 42-inch pipes, which will ultimately be constructed to carry the full quantity of 75 million gallons per day, which is the estimated yield of the Elan Valley works. The first section of the works through the two lines of pipes will convey 27 million gallons of water daily to Birmingham.

The Members then boarded the open truck train, which had been fitted up with seats for their accommodation for the journey through the Elan Valley. The railway runs along the side of the valley for a distance of some six miles, and afforded an admirable observation ground from which to form an opinion as to the general character of the engineering scheme and the method of construction. The railway ride also gave the Members an opportunity of appreciating the advantages of the gathering ground for obtaining and ensuring a constant supply of pure water. In the earlier report of Sir Robert Rawlinson and Mr. Mansergh to the Birmingham Corporation, to which reference was made by Mr. Mansergh in his speech later in the day, the watershed area is stated to be "very much superior to those before described, and, in fact, nothing better can be found in the country, nor could better be desired." Dr. Alfred Hill, the medical officer of Birmingham, in a report on the quality of the water, says, "It is a pure and most excellent water for all practical purposes, domestic and otherwise, and shows what may be considered absolute freedom from animal pollution." This is quite in accordance with the generally-formed opinion of the Members who had the opportunity of travelling through the Elan Valley and observing the freedom from all possible sources of pollution which the land has for so long enjoyed, and which the extensive land purchases of the Birmingham Waterworks Committee, acting on the advice of Mr. Mansergh, have secured for all future time. The train travelled up a stiff gradient above the level of the Caban Coch reservoir to a height of 835 feet above Ordnance datum, thence, by way of the Pen-y-Careg dam to the Craig-yr-Allt Gôch, the highest reservoir in the Elan Valley. On the journey Mr. Mansergh and the members of his engineering staff pointed out the various interesting details of this gigantic engineering scheme, and particularly directed attention to the quarries on the other side of the valley, from which is drawn the supply of stone for the masonry required in the construction of the dams. The Members were also able to observe, as Sir Alexander Binnie pointed out, that nature had evidently designed these valleys for the very purpose to which the engineering skill of Mr. Mansergh is applying them, so admirably does their formation fit them for reservoirs. At the Craig Gôch dam, little more than excavation work had been done. The Pen-y-Gareg dam was visited on the return journey, and here building work was in active operation. This dam will be 525 feet in length, and 128 feet in height. The Craig-yr-Allt Gôch dam is 625 feet in length and 120 feet in height. The next point of interest was the submerged dam at Caregg-ddu—one of the most interesting things from an engineering standpoint of the whole of the complicated and extensive works which are in progress in the Elan Valley. The object of this submerged dam is, to retain a sufficient quantity of water in the upper part of the Caban reservoir to permit of its being tapped at such a height as will allow the water to flow to Birmingham on what is known as the hydraulic gradient. The base of the dam is 700 feet above Ordnance datum, a point too low to carry the water by gravitation to Birmingham, where it has to be delivered into the Frankley reservoir at a height of 600 feet above Ordnance datum. This will necessitate a fall of 170 feet in the aqueduct, and, to allow this fall, water cannot be drawn from the Caban reservoir at a lower height than 770. It may be, however, that the water may fall below this level, and hence the construction of the submerged dam, which holds the water in part of the reservoir up to a height of 782 feet above Ordnance datum. The works at this point proved of the greatest possible interest, and considerable time was occupied in their complete inspection. The work was well forward, so that the visit formed a most favourable opportunity for the inspection of the submerged dam. The main dam at Caban Coch was next visited, and here the construction of the dam has made considerable progress. The dam here is 120 feet high exclusive of foundation, and, starting at the base with a thickness equal to the height, the walls rise in a curvilinear slope. The length of the dam is some 600 feet. The culvert, which has been put in during construction of the work to carry away the flood water, which pours down in huge volumes, was inspected, and the whole of the extensive works were gone over by the Members. When the works are constructed, and the water collected in the reservoirs, the compensation water will flow through pipes in the culverts to the extent of 27 million gallons daily, or something like six times the present flow of the river. The reservoirs, when completed, will have a capacity of nearly 8000 million gallons. The Members then proceeded—after leaving the train which had so greatly facilitated the inspection of the works—by way of the suspension bridge, to the Elan village, which forms a new and better departure in the housing accommodation of the men employed on works of this description. Everything has been done which can in any way promote the decent, sanitary and healthful housing of the workmen. The wooden-frame village has its recreation room, baths, wash-houses, canteen, hospitals for infectious diseases and accidents, with resident medical attendants and nurses, schools for the children, doss house for strangers applying for work, and such other appliances as go to make up a model, if small, community. The Corporation of Birmingham is running its own public house on lines specially laid down by the committee, by which only reasonable demands are supplied, and only Corporation employees serve. The result of this policy of municipal supervision is that the office of village policeman is a sinecure. The married workmen have their own separate tenements, in which they reside with their wives and families, and the accommodation provided for unmarried workmen is much superior to what has hitherto been provided, and secures for them privacy in their sleeping apartments, and comfortable accommodation for their hours of rest. There is also adequate provision for recreation, including a capital football ground. The efficient sanitation of the village has also been made a feature of the scheme, which has been most successfully carried out. Any extra cost which has been incurred by the Corporation in providing improved accommodation has been amply repaid by attracting a better class of workmen and in retaining their permanent service. As soon as the work of inspection had been completed—

The Members were entertained to dinner in the large recreation hall in the Elan Valley. Mr. Mansergh, C.E., presided, and was supported by Sir Alexander Binnie, President, and Lady Binnie, Miss Mansergh, Mr. E. L. Mansergh, Mr. W. L. Mansergh, Mr. Yourdi, resident engineer, and the Members attending the Meeting.

DISTRICT MEETING AT SUNDERLAND.

November 20, 1897.

Held in the Council Chamber at the Town Hall, Sunderland.

J. Cooper, Assoc. M. Inst. C.E., Vice-President,
in the Chair.

The Mayor of Sunderland (Alderman Bruce) received the Members and offered them a hearty welcome. He referred to the works about to be visited, and *inter alia* pointed out that the electrical installation had been very successful, enabling the electricity to be supplied at a lower price than had been done by any other town.

The Chairman thanked the Mayor for his kindly welcome, and for the use of the Council Chamber.

Mr. Rounthwaite proposed, Mr. Taylor seconded, and it was carried unanimously, that J. P. Dalton be re-elected Honorary Secretary for the Northern Counties District.

The following papers were read and discussed: "Notes on the Specifications of Tyneside Roads," by H. W. Taylor. "Some Municipal Works in Sunderland," by R. S. Rounthwaite. "Sunderland Electric Lighting," by J. C. Snell.

NOTES ON THE SPECIFICATIONS OF TYNESIDE ROADS.

By H. W. Taylor, A. M. Inst. C.E., Newburn-on-Tyne.

In the following paper it is proposed to briefly discuss some of the specifications adopted for the construction of roads, being those chiefly in operation in the urban districts of Tyneside.

c

In all his remarks the Author trusts it will be understood that the materials, methods and prices referred to apply strictly to the neighbourhood of the Tyne.

Asphalt and wood pavings are not considered in this paper, as the metropolitan surveyors are in a much better position to afford particulars and information on these pavements.

The foundation of a macadamised road necessarily depends in great measure upon local circumstances. The local sandstone or free-stone is very generally used upon Tyneside, and an excellent material it is; when broken into uniform lumps or blocks, and carefully hand packed in position, it makes a capital foundation for a road. Where the subsoil is clay, the Author has used a layer of ashes 3 inches to 6 inches thick, below the penning, with good result. The ashes tend to prevent the clay from "sponging," or working upwards between the interstices, and to reduce mud in wet weather. The Author laid one portion of a road in this manner as an experiment, the penning of the remainder being laid upon the clay. During the following winter the result was most marked.

Where roads have to be constructed to bear heavy traffic, such as in the vicinity of docks, wharves and railway sidings, their specification must of necessity be of a very substantial order. The formation generally favoured in such positions is 8 inches to 10 inches of free-stone penning, or 6 inches of Portland cement concrete as the foundation, on which granite or whin-stone setts, 3 inches wide by 5 inches or 6 inches deep, are laid with close joints grouted with pitch. The cost of such a pavement is from 10*s.* to 11*s.* 6*d.* per square yard. Some Councils prefer instead a free-stone foundation 12 inches thick, covered with 6 inches of whin-stone metal, no doubt on account of its lesser expense, but it certainly cannot compare with a sett paving in economy of maintenance. This latter specification costs about 4*s.* 6*d.* to 5*s.* per superficial yard.

For average traffic and roads, such as for building estates, a similar though lighter specification is often adopted. The penning is from 6 inches to 8 inches thick, covered with 4 inches to 6 inches of whin-stone, granite, lime-stone or slag, as the case may be, the cost being from 2*s.* 6*d.* to 3*s.* 6*d.* per yard. The top coating is frequently varied, 3 inches, 4 inches and 6 inches of broken slag or rough gravel being occasionally inserted between the foundation and metalling. A point which is often neglected, though very necessary in regard to a clean road, is to omit all ashes and other rubbish between the foundation and metalling. Contractors, and the Author is afraid architects also, frequently err in this respect.

In the construction of roads on building estates, what is known as "random chip paving" is frequently employed. It is a cheap or bastard kind of sett paving, composed of irregular or random lumps of whin-stone or granite, averaging 5 inches to 7 inches deep. Upon a rubble foundation a layer of fine gravel is spread, on which the chips are hand packed. The whole is then grouted with hot quicklime grout, 2 to 1, and a thin layer of pea-gravel spread over it. The cost is about 4*s.* to 5*s.* per square yard. Random chip paving is a somewhat questionable success, in the Author's opinion. Inasmuch as the chips are not uniformly shaped, the beds must vary, and with average traffic the road loses its shape, and hollows and depressions are formed. It is frequently used in back streets, although it has a multitude of joints in which refuse and fæcal matter is bound to lodge in a district where middens and ashpits are in vogue. It is an exceptionally noisy pavement when a little worn, its one advantage being that it costs but little to scavenge and maintain compared with ordinary macadam.

In place of penned rubble, a foundation of *lime* concrete is sometimes employed, about 6 inches in thickness, as at Tynemouth and South Shields. This is a somewhat unusual foundation in the Author's experience. It is well known that Portland cement concrete has been very successful, but it is somewhat uncertain as to *lime* concrete being so upon a soft clay subsoil. It is necessary that the lime concrete be laid in fine weather. The lime referred to is the ordinary white building lime (not the grey lias lime), and should be slightly hydraulic for this purpose, some limes being almost useless for such work.

Tarred macadam is not used to the extent it perhaps deserves; it is clean and impervious, and as it can be washed with ease it is an unrivalled cheap paving for back streets in a midden town or district. Some considerable skill and manipulation is required in properly mixing and laying tarred macadam, and there is no doubt that it has got into disrepute through inattention or neglect of these matters. The stone must be thoroughly dry before coating it with the tar. Tar from a gasworks where a regenerative heat is used is almost worthless; the tarred metal should not be laid less than 6 inches in thickness, it must be laid in dry weather and the traffic kept off it for three or four days. The cost is from 3*s*. 6*d*. to 4*s*. 6*d* per square yard.

On sanitary grounds tarred macadam is preferable to the usual random chip paving with its multitude of joints. It certainly has the disadvantage of being somewhat difficult of repair. Let a water or gas company having powers in the district get wind of such a street having been made up, and it will at once become a fair mark for them. On principle their men will never be satisfied until there are a dozen holes in it. Such is the Author's wearisome experience, tarred macadam seeming to act as a magnet upon some folk.

The widths of roads required in building estates seems to be from 36 feet to 60 feet; back streets from 15 feet to 24 feet, the average being 18 feet wide. They vary, no doubt, as to whether the council works under the model bye-laws or a private Act. The corporations of the larger towns, having private Acts, demand as much as 50 feet to 60 feet for roads likely to become main thoroughfares. At Sunderland a somewhat unusual though very practical rule is in force. In this case the width of the road depends upon the height of the abutting houses, thus: the road must be 30 feet wide where the height of the eaves does not exceed 17 feet; 40 feet wide where they do not exceed 26 feet high; and 50 feet wide where the height exceeds 26 feet.

For the paving of footpaths Caithness flags are very generally used in this neighbourhood: the No. 1, averaging 3 inches in thickness, being laid in the main thoroughfares; and No. 2, averaging 2 inches in thickness, in other roads. The price per square yard is about 6*s*. 6*d*. and 6*s*. for the No. 1 and No. 2 respectively, laid complete.

Cement concrete footpaths laid *in situ* are extensively used. It is usually composed of crushed granite and Portland cement in the proportion of about 3 to 1, laid 2 inches to 3 inches thick upon a foundation of 4 inches to 6 inches of broken rubble, and costs from 3*s*. to 3*s*. 9*d*. per superficial yard. In the Author's opinion it is a mistake to lay such concrete in long continuous lengths, as one so often sees done. It ought to be laid in bays about 5 feet or 6 feet wide, making provision for expansion.

Instead of the usual thin laths left in between the bays, and which are somewhat unsightly, the Author has painted the edges of the first laid bays with a mixture of clay and water of the consistency of cream, which has answered every purpose. He had several streets to make up a short time ago, where cost was considered all-important. The specification adopted was 4 inches of broken stone or brick foundation, 1 inch of concrete composed of 3 parts crushed brick to 1 of cement, with a top layer, also 1 inch thick, composed of 5 parts crushed granite to 2 parts cement. The two layers of concrete were laid in one operation, that is, the upper layer was laid while the lower one was still wet. It is imperative, where concretes of different admixtures are laid, that the work be thoroughly supervised while in progress. The result in this case is satisfactory, the cost being 2*s.* 8*d.* per superficial yard only.

Very little York flagging is laid, which seems somewhat remarkable, considering that the Tyne is not an excessive distance from the Yorkshire quarries. Nor does artificial flagging seem to meet with much favour; although at Darlington it is used extensively, with excellent results. Imperial, Victoria, and Adamant flags are all first-class articles, quite equal to Caithness, and better perhaps than York. They are of a light and cheerful appearance, and free from that objectionable feature of natural stone, viz. wearing unduly at the edges and corners. The Author has laid many thousands of these artificial flags, which have given every satisfaction. Considering that the time during which *in situ* work can be laid is limited here, on account of frosts, to some six months only in the year, it is astonishing that artificial flags are not more generally used, as the cost is very moderate.

Fifeshire whin-stone kerb is universally used in this district, the 12-inch by 6-inch flat kerb being usually preferred, though in a few cases the 6-inch by 12-inch edge is used. Of late years granite has to some considerable extent taken the place of whin-stone, the Norwegian and Scotch products being delivered in the Tyne as cheaply as whin-stone, and are equally as good. A cheaper kerb where price is an object is the Marsden lime-stone, obtained from the Marsden Quarries near South Shields, and a very hard free-stone from the Heworth-on-Tyne Quarries. These, in the Author's opinion, are only fitted for suburban streets where the traffic is light, and it is advisable to use granite or whin-stone quadrants in all cases at the corners of streets.

Channels are generally formed of two to five rows of whin-stone setts. In many cases these channels are rather narrow, the average width being only about 8 inches. In a few of the districts a single stone 6, 7 or 8 inches wide constitutes the channel. In the Author's opinion channels are often much too narrow, and should not be *less* than 13 inches wide in macadamised roads. Scoria bricks 9 inches by 4 inches by 5 inches deep make an excellent channel, being of uniform size. Channels composed of scabbled free-stone blocks when evenly laid have a very pleasing appearance. A cheap and fairly satisfactory channel, where expense is an object, is to lay tarred macadam about 18 inches wide next to the kerb; being impervious it answers fairly well in rural roads, but must not, of course, be compared with a sett channel.

Of all road metals, the most local, universally used and generally favoured, is the famous Northumberland whin-stone. It is hard and durable, its wearing properties being of the first order. The Author is rather favourably disposed towards granite as a macadam: Aberdeen (from whence nearly all our granite macadam is obtained) Cove granite is well spoken of; it may not perhaps stand quite so heavy a traffic as whin-stone, but it bears an ordinary traffic well. It makes a smooth road, and has the great advantage of not working loose in dry weather. The Author has experienced great difficulty in getting some of the Northumberland whin-stones to lie in summer, the metal *will* kick up, and under heavy traffic very soon loses its angularity. The Author is, of course, assuming that a steam roller has been used in each case. The hard blue mountain lime-stone, such as is obtained from Alston, is very suitable for inclines (or "banks," as they are locally termed) and roads of a rural character. It should be thoroughly steam-rolled as soon as it is laid, with a roller preferably not exceeding 10 or 12 tons in weight. It is sometimes objected that lime-stone is muddy in wet weather, and under heavy traffic this is undoubtedly so, but with light and medium traffic it is an excellent stone. It makes a smooth road, one much appreciated by cyclists, and, when once rolled in, it lies splendidly, even in the driest summer weather. The general consensus of opinion of iron-stone slag as a road metal is that it is worthless and does not pay for the labour of laying on. As it is now produced it is full of honeycomb and quite undesirable. In some of the outlying roads, where the traffic is light, it is still used as a metalling, but the practice is gradually ceasing. As a foundation it is admissible, but in the Author's opinion it is not equal to free-stone, as it has little or no "jambing" property, and cracks and crushes beneath the roller.

Before concluding, the Author would like to comment upon the roads, or rather want of roads, usually found abutting upon colliery houses. Generally speaking, the roads, if they can be called such, are composed of ashes of various thickness according to the length of time the cottages have been built. The tenants usually spread their ashes at their doors, and very little else is done in the way of road making. In a few cases a layer of pit post or free-stone has been laid below the ashes as a foundation, but this is quite the exception and not the rule. In wet weather a great amount of dirt is carried into the houses, while after a frost the ashes "lift," adhering to the boots and shoes of pedestrians. It seems remarkable that in these *fin de siècle* times something better is not done. Authorities, on Tyneside at any rate, seem very indisposed to require any such roads to be properly made up, as is usually done for building estates. Whether the coal trade cannot stand such an impost the Author does not know, but the present state of things is frequently deplorable.

The Author has to thank those surveyors who have been kind enough to supply him with information and particulars respecting the specifications in their districts. It is his intention to have them tabulated and printed, and to send copies to each of those gentlemen.

In conclusion, the Author fears he has not brought forward anything very new, but hopes, rather, that it may produce a good discussion, and if it helps to clear up any doubts or remove any difficulties his paper will have served its object.

SOME MUNICIPAL WORKS IN SUNDERLAND.

By R. S. ROUNTHWAITE, Assoc. M. Inst. C.E.,
Borough Engineer, Sunderland.

At the earnest solicitation of your local secretary, the Author has been persuaded to consent to the holding of another meeting in this town, notwithstanding the fact that the last meeting of the Northern District was also held here in March 1889 (eight and a half years ago). Possibly if this opportunity had been allowed to pass over, we might have had no meeting for another eight and a half years. Rather, therefore, than allow a further period to elapse without a meeting, the Secretary and the Author considered it better you should meet here again, though the Author doubts if there is much work in progress which will be of general interest to the Members of this Association. The Author sincerely trusts that the Members of this Northern District will in the future take a greater interest in the welfare and progress of the Association, and will not allow another year to pass away without holding at least one meeting; for he is strongly of opinion that our meeting together in this way, and seeing whatever is to be seen, and interchanging our views upon various current topics, is beneficial to ourselves as well as to the Councils we represent.

The subjects to which the Author wishes to draw attention to-day are—

The Housing of the Working Classes.
Proposed Technical School.
A New Hospital Pavilion.

The Author has not been able, owing to pressure of work and indisposition, to write anything like an exhaustive paper on each of these subjects. His object is simply to describe, in as few words as possible, the details of these schemes, which are now under the consideration of his Council; to present to your inspection the several drawings in connection with these works; to elicit some discussion thereon; and to give such further information to Members with respect thereto as lies in his power.

HOUSING OF THE WORKING CLASSES.

The adoption of the 1890 Act having reference to this subject has in this, as in many other towns, received the careful attention of the Council and of the Health Committee.

A large number of insanitary areas in the older part of the town were, in 1892, inspected and reported on by the then Medical Officer of Health (Dr. A. E. Harris, of Islington) and the Author. The Health Committee however, very wisely the Author thinks, confined their attention, in the first instance, to one of the worst districts, known now as the "Hat Case Area." This district was taken in hand as being of small area, as one occupied for the most part by working classes of the poorest kind, and for the purpose of finding out by experiment how the Act would really work.

The total area now being dealt with comprises, in streets, courts, alleys, land and buildings, only about two acres, of which 2404 yards or thereabouts are intended to be used for the erection of workmen's dwellings, the remainder being thrown into adjoining streets and utilised for new streets.

The total number of houses and buildings which have been taken is sixty-three, and the number of persons unhoused 480. It is proposed to erect new dwellings of three stories in height, and as shown in detail upon the drawings laid upon the table.

The whole of the properties have been purchased by private arrangement, at as nearly as possible the amount estimated by the Author as their value, and in no single instance has it been necessary to have recourse to arbitration as provided by the Act.

The necessary Provisional Order was obtained in 1894, and competitive designs were in September of last year invited by the Council, three premiums being offered for the three first selected designs.

In response, fifty-three sets of designs were received. These were adjudicated upon by Mr. John Slater, F.R.I.B.A. (on the recommendation of the President of the Royal Institute of

British Architects), and his award in favour of the designs under the motto "Pro Artifice," which you have before you (the authors being Messrs. Perry and Angell, of Garrick House, York Buildings, Adelphi, London, W.C), was accepted by the Council. With some slight modifications, and after interviewing the architect to the Local Government Board, these designs have been formally submitted to the Board for approval, and it is hoped that their sanction will be obtained at an early date.

The accommodation provided in three blocks by these plans, as last amended, consists of 24 three-roomed self-contained tenements at a rent of 4*s*. 3*d*. per week; 71 two-roomed ditto, at 3*s*. 6*d*. per week; and 13 single-roomed ditto, at 2*s*. per week.

Allowing two persons to each room, it will therefore be seen that of the 480 persons unhoused provision will be made for 454, and this it is hoped will satisfy the Local Government Board, although the terms of the Provisional Order require that the full number *displaced* shall be provided for.

It is, of course, difficult, if not impossible, to say to what extent this scheme may be self-supporting. Calculated on the rentals named above, and which are such as the Author believes will be easily obtained, the total gross revenue will be 978*l*. 18*s*. per annum, whilst the outgoings, including insurance, repairs, collection, caretaker, inlets, rates and taxes, are estimated at 332*l*. 16*s*. 6*d*. This leaves a net annual income of 646*l*. 1*s*. 6*d*., which is sufficient to cover the interest and sinking fund on the total estimated cost of the scheme (16,402*l*.) over a period of 40 years, with interest at the rate of 2½ per cent. per annum.

The Author may perhaps just shortly refer to one or two of the principal features of the designs before you. They are, as will be observed, and as competitors were instructed, plain and substantial. All the living rooms and most of the bedrooms abut on the wider streets, where they will have the benefit of better light and air, whilst the staircases, sculleries, offices, and some few of the bedrooms, abut on the narrower courtyards. All the rooms are of sufficient size and height to comply with the memorandum of the Local Government Board. Each tenement is provided with a separate scullery, a separate water-closet in nearly all cases, a copper, sink and draining board, ash-bin and coal bunker, as well as sufficient cupboard accommodation.

In very few cases is it necessary to pass through one room to another, entry being direct from the landing. In the architect's original designs it will be seen that they had so arranged the tenements that this was unnecessary in any *single* instance, but, owing to the modification of the plans and the increase in the size of rooms, they have been obliged in a few cases to pass from the living to the bedroom.

Floors, roofs and stairs will all be of fireproof construction, and the entrance to each group of tenements will be by a direct stone staircase from the courtyard, thus avoiding the objectionable gallery, which tends to shut out light from the rooms below and to prevent privacy. These staircases will be well lighted and ventilated, and will provide a ready means of escape in case of fire. They will be carried up to the roof level, which is intended to be used as a drying ground and also as a playground for children.

In blocks Nos. 1 and 2 the courtyard or private roadway will be 20 feet in width, with gates at either end, thus keeping the tenements well under the control of the janitor, who will reside in one of the blocks.

Each tenement having a separate scullery and copper, &c., it has been thought unnecessary to provide a common laundry, as is so frequently done. The bath rooms shown on the original plans are now proposed to be omitted, in view of the fact that one of the public bathing and washing establishments is situated at no great distance from the site of these dwellings.

The buildings are proposed to be erected in brickwork upon cement concrete foundations, and faced on front elevations with red bricks and moulded cornices. That portion of the external main walls between the pavement level and the under side of ground floor window sill will be in blue Staffordshire bricks. The construction will be fireproof throughout, the steel floor joists being completely encased in concrete, and the steps and landings will be finished with a granite surface.

The flat roof will be covered with asphalt and well railed round, each three tenements having a distinct and enclosed section to themselves as drying ground and playground.

The open staircase walls will be built in white glazed bricks with bull-nose angles; and gas will be provided on the stair landings only.

The courtyards will be paved with granite-faced concrete, as also will be the flooring of lobbies, sculleries, &c.; and the living and bed rooms will have boarded floors secured to wood fillets laid in the concrete.

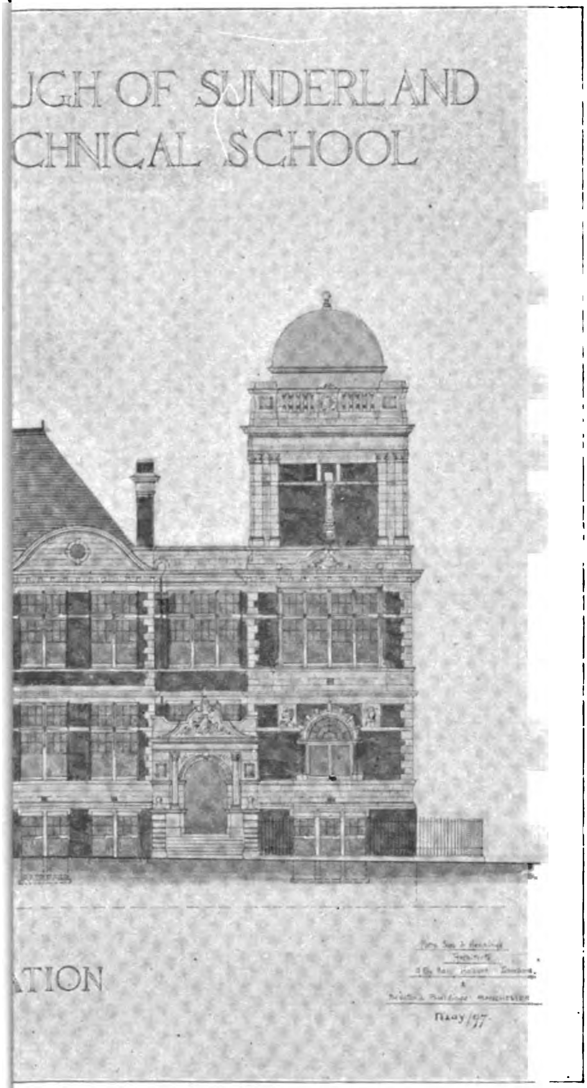
PROPOSED TECHNICAL SCHOOL.

On this subject the Author desires to say only a few words, his object being mainly to give the Members present the opportunity of seeing the plans, elevations, &c., which have been practically approved by the special committee having charge of the subject. This committee is formed of members of the Council, and of gentlemen outside of it who have taken a deep interest in the question of education. Upon the absolute necessity of giving every possible facility to our young men of increasing their technical knowledge, the Author considers it is not requisite for him to say anything, for it is admitted by all that if we are to keep ahead of other nations, or even alongside of them, we must offer advantages and facilities for training our apprentices similar to those which are offered and fostered by other nations. Instead of paying away the Government grant, which is received annually, in subsidising existing schools, only a very small part of such grant has been so dealt with, and the remainder has been allowed to accumulate so that a public central technical school might be established.

The whole of the funds necessary for the erection and equipment of such a school have, however, not yet been obtained from the source above referred to, and the question of providing the balance will probably occupy the attention of the committee and of the Council at a very early date. The probable cost of the whole scheme will be, in round figures, about 20,000*l.*, and of this sum about one-half remains to be provided. So far, the Council have purchased a most eligible and central site, of sufficient area to allow of such extensions in the future as may be found necessary. They have also invited designs in competition (offering three premiums of 100*l.*, 50*l.*, and 25*l.*, for the three first selected), and from forty-three sets of designs submitted they have unanimously accepted those of Messrs. Potts, Son and Hennings, of London and Manchester, who were awarded first place by the assessor. In this competition the

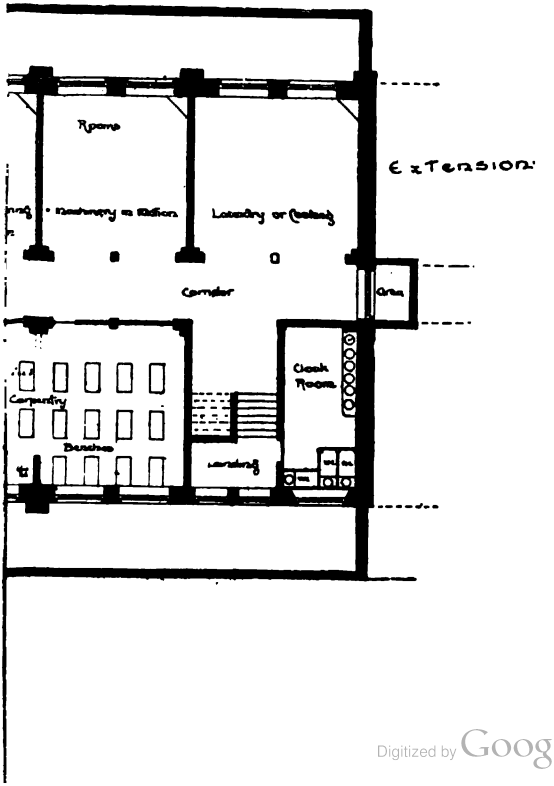
ND TECHNICAL SCHOOL.

EVATION.



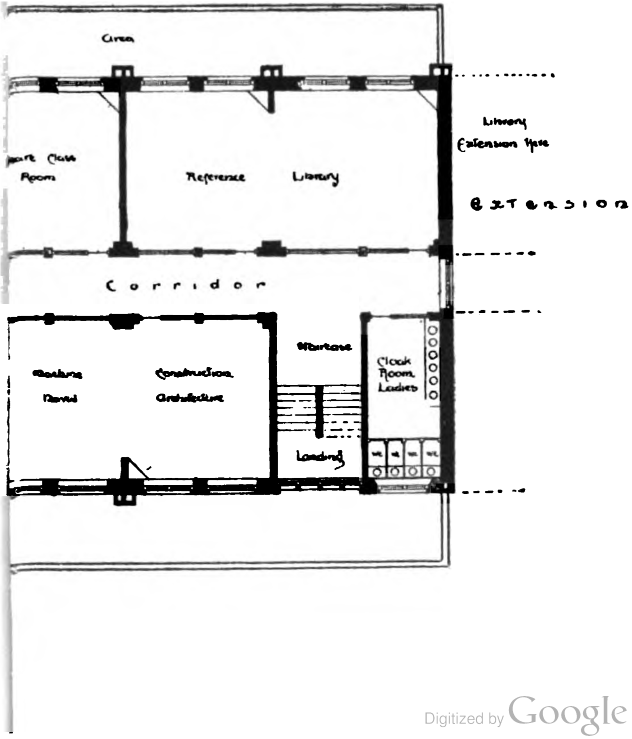
ECHNICAL SCHOOL.

N.



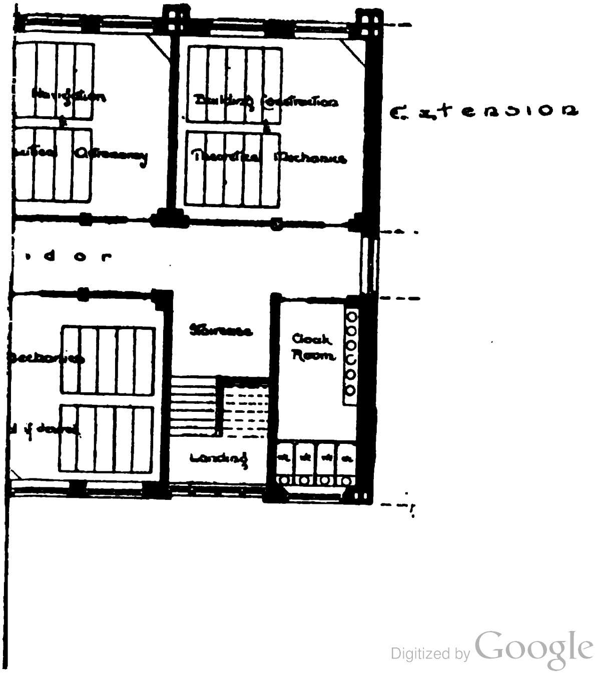
D TECHNICAL SCHOOL.

OR PLAN.



ECHNICAL SCHOOL.

AN.



Council asked the President of the Royal Institute of British Architects to appoint an assessor, which he did in the person of Mr. J. McK. Brydon, F.R.I.B.A. After consultation with the committee the architects were desired to modify their plans in some respects, and tracings of these plans as modified are now laid before you.

The accommodation provided is as follows, viz.:—

In the Basement.—Physics Lecture Theatre, 30 feet 6 inches by 23 feet; Preparation Room, 23 feet by 9 feet; Elementary and Advanced Physical Laboratories, 30 feet by 19 feet 3 inches, and 23 feet by 19 feet 6 inches; Plumbers' and Sanitary Engineering Workshop, 27 feet 9 inches by 19 feet; Carpentry Workshop, 41 feet by 22 feet; Spare Rooms for Experimental Engineering and Testing Machine, 23 feet by 21 feet; Machinery in Motion, 20 feet by 21 feet; Laundry or Cooking, 23 feet by 21 feet; Cloak Rooms, &c., Store Room, Heating Chamber, Coals, &c.

On the Ground Floor.—Hall for Examinations and Public Lectures, 70 feet by 30 feet; Principal's Room, 17 feet by 10 feet 6 inches; Masters' and Committee Room, 22 feet by 16 feet 6 inches; Spare Class Room, 23 feet by 22 feet; Room for Mathematics, 43 feet 9 inches by 22 feet; Room for Machine Construction and Naval Architecture, 40 feet 9 inches by 22 feet; Cloak Rooms, Offices, Stores, &c.

On the First Floor.—Chemical Laboratory, subdivided (with Balance Room and Combustion Chamber), 81 feet by 30 feet; Science Masters' Room, 17 feet by 12 feet; Chemistry Lecture Theatre, 29 feet by 22 feet; Preparation Room, 22 feet by 9 feet 6 inches; Room for Navigation and Nautical Astronomy, 22 feet by 22 feet; Room for Building Construction and Theoretical Mechanics, 23 feet by 22 feet, Reference Library, 20 feet 6 inches by 18 feet 9 inches; Room for Steam and Applied Mechanics, 40 feet 6 inches by 21 feet 6 inches; Cloak Rooms, &c., 20 feet and 10 feet by 21 feet 6 inches.

On the second floor are situated the caretaker's rooms, and in the tower at corner is a room allotted for clock, chronometer testing, and other apparatus used in nautical study; whilst over it, and reached by a circular iron staircase, is a telescopic dome, to be constructed in the usual manner to revolve on a series of running wheels.

The plans are so arranged that all parts are readily reached, are well under the supervision of the officials, and are capable of easy and economical extension. The main floor is placed about 8 feet above the street level, and is approached by an easy flight of steps. The floor space provides 10 superficial feet for each student when used for examinations, and 5 feet superficial for meetings. There will be two large entrances to the hall, enabling it to be rapidly emptied. The main corridor is 8 feet wide, and the main staircase 6 feet wide, and the whole of the rooms will be well lighted with left-hand lights. A large hoist is also provided, communicating with each floor.

The Chemical Laboratory is lighted upon both sides and end, and in addition has a continued skylight on the north-east side of the open roof.

There is a clear space of 29 feet to the ceiling, and in the centre is a turret containing an extract ventilator. The benches are arranged in rows across the room, each spaced for twelve students, whilst provision is made for the necessary shelves and fume closets, fitted as required by the Science Department.

This room provides 600 cubic feet for each student.

The Combustion Chamber will be fitted with two furnaces, each having a separate flue, and lighted by a skylight having louvres at the sides.

In the Chemistry Lecture Theatre there is seating for sixty students; and this room is fitted with a demonstration table, and desks on raised benches with lumber space under.

It is intended that the whole of the rooms shall be lighted with electric light from the Corporation's system. The heating will be by means of hot-water pipes, with radiators where necessary beneath the window cills, and through which will be passed a current of fresh air.

Ventilating grates will also be used in addition to the hot-water system.

For the extraction of foul air, flues are provided at the level of ceilings and carried up to the highest point.

The windows are carried right up to the ceilings and open in every part, the lower sashes being double hung, with transoms falling inwards.

There are six cloak rooms in all, with the necessary sanitary accommodation, arranged in two tiers.

The drainage and plumbing work will be carried out on the latest and most approved principles.

The floors of building will be constructed with steel joists and concrete, and the roof will also be of concrete and asphalt.

Hydrants will be placed in convenient positions, and grenades and sprinklers will also be supplied for the extinction of fire.

The elevations show a type of English Renaissance, faced with red bricks and stone dressings.

The foundations will be of concrete, and damp courses of asphalt. The roof will be covered with green Westmoreland slates.

Carpenter's and joiner's work will be of red wood, except internal joinery, which will be of American yellow pine.

The dados will be of brown glazed bricks.

The floors will be of fireproof construction, overlaid with 1¼-inch battens on bevelled slips.

The corridors, cloak rooms, &c., will be of concrete with granite face.

Hot and cold water will be supplied to all lavatories and sinks, and cold water to all benches in fume chambers in chemistry and physics rooms.

A New Hospital Pavilion.

Since the erection of the Sunderland Fever Hospital, a description of which will be found in a paper read by the Author at the last meeting in Sunderland (March 23, 1889, see vol. xv. of 'Proceedings,' p. 28), it has been found necessary to increase the accommodation for the treatment of patients. The Council has therefore decided to erect a new pavilion for scarlet fever cases. This will be built in the position shown upon the site plan laid before you, and pretty much on the same lines as the older pavilions, except that each of the wards, male and female, will be 84 feet long instead of 48 feet, and twenty-eight beds will be provided for instead of sixteen.

This new pavilion will, like the others, be one story in height, and will contain two large wards for male and female patients. Each patient will have a floor space of 156 superficial feet, and an air space equal to 2028 cubic feet, which is, I believe, slightly more than is required by the Local Government Board.

Each ward will accommodate fourteen patients, and will be 84 feet long by 26 feet wide, and 13 feet high. They will each be heated by means of two large single hot-air gill stoves, with flues ascending directly over them to the ridge of building. In the older pavilions, the flues *de*scended, and were carried under the floors to the external walls, and up to and above the ridge level, but these were never found to be satisfactory; the only advantage they possess is that there is no obstruction to the view from the window of the nurses' duty room over the pavilion.

In addition to these stoves, the wards and the annexes will be heated by means of hot-water pipes on the low-pressure system. Under the pavilion will be constructed a chamber to contain a calorifier, and to this calorifier will be laid on a steam pipe from the central boiler, which will set up the circulation of hot water, both for heating and washing purposes. In each of the annexes, containing water-closets, urinals, sinks and lavatories, there will be provided a radiator, so that the temperature in these annexes may be maintained slightly higher than that in the wards.

It will also be observed that these annexes are entirely cut off from the wards by means of a short corridor and cross ventilation.

The vitiated air will be extracted by means of specially constructed ducts surrounding the smoke flues, and surmounted by Boyle's patent air-pump ventilators. There will be two of these ventilators over each ward.

The windows will be double hung with deep bottom rails, so as to admit fresh air at the meeting rail without draught, and over these windows will be hinged transom lights formed to open inwards at the top against a hopper, also provided to prevent down draught.

Under each bed there will be constructed a fresh-air inlet with sliding door for adjustment.

The central portion of the building will be altered somewhat from the original design, as will be seen by comparing the two plans before you.

The nurses' duty room will remain as now, but the entrance to the pavilion will be placed centrally, and *two* bath rooms will be provided, one on either side of the entrance. There will also be a store room, linen closet, and housemaid's closet.

The building will be erected with Sherburn House or Birtley bricks, on cement concrete foundations, with dressings and strings of Prudham stone, and steps from Heworth Burn Quarry. The plinth courses and relieving arches will be of red brick, and the band courses in buff, to correspond with the existing buildings. The roofs will be covered with Port Dinorwic slates, fastened to boarding with copper nails. The external walls will be built hollow to ensure dryness and warmth; and the whole of the site of the building will be covered with Portland cement concrete.

The estimated cost of the building, exclusive of furnishing, is 2810*l*.

SUNDERLAND ELECTRIC LIGHTING.

By J. C. SNELL, Assoc. M. Inst. C.E., M. Inst. E.E.,
Borough Electrical Engineer.

The Provisional Order was granted in June 1891, and in 1893 the Corporation appointed Prof. Alex. B. H. Kennedy, F.R.S., M. Inst. C.E., to be their Consulting Engineer; a report was submitted by him, and, being deemed satisfactory by the Council, Prof. Kennedy was instructed to prepare the drawings and specifications for the first installation at the station. Some difficulty was experienced in obtaining a site for the station, which, had it been by the actual river-side, would have given us the great advantages of condensation, and the present site, on which was situated the Fever Hospital, was settled upon. Prof. Kennedy recommended a low-tension three-wire direct-current system for the compulsory area, and a high-tension alternating-current system for the more outlying residential districts.

Buildings.

The buildings were erected from the designs and under the superintendence of Mr. R. S. Rounthwaite, A. M. Inst. C.E., the Borough Surveyor; these comprise a stokehole 44 feet by 43 feet 6 inches (since extended), an engine house 48 feet 6 inches by 39 feet, a battery room 39 feet by 18 feet, and the general offices and stores. The chimney is circular, 120 feet in height from the flue level, and is 6 feet in diameter at the top. This is lined for a height of 80 feet in fire-brick, an air space having been left between the lining and the outer walls. The foundations of the chimney and engine beds are on the marl rock.

Plant.

The original installation comprised three Lancashire boilers, 28 feet by 7 feet 6 inches diameter, made by Hawksley Wild, of Sheffield, working at 125 lb. pressure. The evaporation of these boilers from and at 212° Fahr., was over 6000 lb. per hour on test. Each boiler is provided with a steam drum, spring safety valve with easing gear, and a "Quad" dead weight and low-water valve. Two Babcock and Willcox water-tube boilers, each of 6000 lb. evaporation, and a Green's economiser were added by the late electrical engineer. The first set of pumps comprised two vertical duplex Worthington pumps, each capable of delivering 3000 gallons of feed water per hour against the boiler pressure, and 4500 gallons per hour if pressed. The feed water was obtained from an underground reservoir capable of storing 5000 gallons, and a second way direct from the water company's main. The water, after passing through a Kennedy water meter, is pumped through a Berryman's exhaust steam heater, made by Jos. Wright, of Tipton, and from thence from either of two feed pipes, the feed pipes being duplicated right up to the boiler shell. Steam is taken from two parts of the main range of steam pipe to drive the pumps. An overhead cast-iron tank and water softener have recently been added.

The boilers deliver the steam into a 6-inch ring main: the straight lengths are of mild steel, and the bends of solid drawn copper with steel flanges. Valves are inserted at intervals to disconnect any faulty section, and the arrangement is such that steam can be obtained at each engine by one of two ways, thereby decreasing the liability of any set being laid off through accident to the steam range. Solid drawn copper drain pipes are taken off at intervals, and are "teed" into a duplicate drain-pipe connection to Royles' "Syphonia" traps. These traps are now made to deliver their discharge water into an overhead tank 16 feet above the ground, from which the water returns by gravitation to the feed tank.

The original five engines are by Willans and Robinson, and are their well-known compound high-speed central valve type. The two small machines are 50 H.P., each running at 520 revolutions per minute, and the three others, each of 80 H.P., running at 450 revolutions per minute. The engines are direct coupled to dynamos made by I. H. Holmes and Co., of Newcastle-on-Tyne. There are two dynamos coupled to the former engines, each of 26 kilowatts output, and wound for a pressure of 110 volts, being used for balancing the load on the three-wire system and for charging the batteries. The three other engines are coupled to dynamos of 50 kilowatt output, each wound for 220 volts.

The station was extended last year under the then electrical engineer, Mr. C. S. Vesey Brown, and two steam dynamos of 220 H.P. were added. These engines are high-speed, by Belliss and Co., Birmingham, running with their well-known forced lubricator system, and direct coupled to dynamos made by T. Parker, Ltd., of Wolverhampton, each of 125 kilowatt capacity at 220 volts pressure. Both types of engine run exceedingly well.

The Author has not the figures of steam consumption of these particular Willans engines, but the Belliss sets tested by him last year required only 18·7 lb. water per B.H.P. hour full load, 19·8 lb. at half load, and 20 lb. at quarter load condensing. Another 360-H.P. set, consisting of a three-crank tandem compound Belliss engine, direct coupled to a Holmes 4-pole 225-kilowatt dynamo, will be running in a few weeks, and is being supplied to the Author's specification. The foundations only are now in. The last machines have been designed so as to be easily adapted to a pressure of 440 volts, to enable the Corporation to take advantage of the recent increase in limit of low-tension supply as define by the Board of Trade, an increase which will materially extend the economical area of supply by low-tension direct currents.

The low-tension switchboard was originally designed by Prof. Kennedy after his well-known types; each dynamo has on one pole an automatic cut-out, and ammeter, and the other pole a fusible cut-out. These are strapped to vertical copper bars on the face of the slate, and can be plugged to any of the horizontal "omnibus" bars on the back of the slate. Beside the dynamo bars are the feeder bars, which can also be plugged to the 'bus bars. By this means three distinct pressures can be maintained, if needed to deal with various loads on the feeders supplying the network. Each feeder has an ammeter, a two-way switch, and a pair of fuses on each pole. The positive poles are all kept to the left panels of the switchboard and the negative poles to the right. The centre panel is devoted to the centre wire ammeter, which indicates the want of balance of current in the two sides of the system at the station, and the battery regulating switch gear and voltmeters. These voltmeters are connected to switches, which are themselves connected to the pilot wires led back from the various feeding points in the network, and indicate the pressure at those particular points. The output is read by Kelvin meters fixed to the wall. Control of pressure is regulated by rheostats fixed on the hand rail.

A battery of 126 cells was installed, and can store up sufficient energy to maintain 740 8-C.P. lamps for four hours. The cells consist of two sets of seventeen plates in parallel, and are guaranteed to discharge 100 ampères for four hours. These were supplied by the Electrical Power Storage Co., and are maintained by them for a period of three years under contract with the Corporation. The regulating switch for controlling the battery is situated in the battery room. The floor of this room is paved with Limmer asphalt, and this has withstood the acid and wear exceedingly well.

The alternating plant consists of two motor alternators supplied by Crompton and Co., of Chelmsford. The motors are direct coupled to the alternators, and are driven by the low-tension plant across the two outer conductors at a pressure of 220 volts. The alternators, each of which has an output of 38 kilowatts, gives a pressure of 2500 volts at a periodicity of 55 cycles per second. The high-tension switchboard is distinct from the low-tension, of course, and was supplied by Crompton & Co. Two panels are allocated to the controlling instruments and switches for the motors, and the remainder to the alternating circuits. Each alternator is connected through an ammeter and long-break fuse to one side of a pair of contacts, and circuit is made by the insertion of a well-protected plug. There are two 'bus bars, to which either or both of the alternators can be connected, and either or both of the two existing primary mains through ammeters and long-break pieces. A synchronising switch and lamp are provided.

MAINS.

The low-tension mains are mostly of india-rubber cables, supplied by the India-Rubber, Gutta-Percha and Telegraph Works Co., drawn into Doulton stoneware conduits, and the positive and middle wire are laid on one side and the negative and middle wire on the other side of the streets. The standard sections adopted are 0·15-square inch outers and 0·1-square inch middle wire. The feeders are partly of bare copper strip on the Kennedy system, laid over porcelain insulators in concrete culverts, and partly of armoured india-rubber cable laid in the ground. An objection to the armoured cables, in the Author's opinion, is the extreme liability to damage by picks, etc., when the ground is being opened by other companies, and against which the steel tape armouring is of little avail according to his experience. A new indiarubber-covered feeder has recently been drawn into Doulton conduits—this system, or cast-iron pipes, having been the only available draw-in system permissible in the particularly narrow streets. In the distributing system, boxes for house connections are laid about every 15 yards.

The alternating mains are on the concentric system, with one pole earthed, and are served by two primary feeders at 2500 volts. Transformers in cast-iron cases are placed in the streets at intervals, and connected by a switch and fuse to the primary. The second, or low-tension mains, at 110 volts pressure, are taken from these to the houses. The primaries are lead-sheathed paper-covered concentric cables of the British Insulated Wire Co., drawn into stoneware conduits, and the secondaries are armoured and lead-sheathed concentric cable, laid in creosoted wood troughing and run in solid with a bituminous compound.

A system of arc lighting in the principal public streets is about to be inaugurated. The contract for lamps has been let to Crompton and Co., of Chelmsford, and these will burn four in series across the outers of the low-tension three-wire system. The poles are being supplied by J. Spencer, of Wednesbury, and are of steel in two sections, the upper section tapering, and the poles being set in ornamental cast-iron bases. The reason for the adoption of steel poles is their possible requirement for the support of overhead wires for electrical traction. The lamps will be suspended from swan necks at a height of 21 feet from the ground, and will be placed about 60 yards apart.

The following tables will show the progress of the station since the commencement of supply.

It will be seen that in two years the number of lamps connected has been more than quadrupled ; so far, although a big profit has been made on the actual working of the station, there has been a charge on the rates in each of the two years, interest and sinking fund being included. But there is every probability of this charge being very much reduced during the current year as compared with last year, and of there being an actual surplus during the next year, after paying something like 2400*l.* for sinking fund and interest on that year.

TABLE I.

Year ending	Units Sold.	Total Costs.			Sinking Fund and Interest.			Grand Total.			Revenue.		
		£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
April 1, 1896	95,140	1451	0	10	1357	6	1	2808	6	11	2165	14	9
" 1897	146,385	2024	0	8	1672	12	10	3696	13	6	2714	7	10
" 1898 (estimated)	248,631	2890	13	8	2217	15	9	4579	18	8	4165	9	2

TABLE II.

Quarter ending	8 C.P. Lamps Connected.	Units Sold.	Max. Load in E.H.P.	Number of Consumers.
July 1, 1895	2,894	8,324	46	33
Sept. 30, "	4,172	11,550	86·2	54
Dec. 31, "	5,995	38,294	174	83
April 1, 1896	7,724	36,972	171·6	95
July 1, "	8,547	15,552	132	104
Sept. 30, "	8,764	19,797	157·8	104
Dec. 31, "	11,289	55,875	294	113
April 1, 1897	12,672	55,162	256	125
July 1, "	12,958	30,789	243	126
Sept. 30, "	13,771	37,842	264·3	139
To date	17,476	—	301·1	155

Sunderland supplies current to its consumers at the cheapest rate in the three kingdoms (whether municipal or private company), the average price paid per unit during last year having been only 4·09*d.*, and the next lowest having been Newcastle at 4·14*d.*

The apparent anomaly of an increased charge on the rates during the second year is explained by the fact that the Corporation reduced their prices to consumers by one-sixth during that year, and also the interest and sinking fund on the major part of the extensions became payable before that plant was really earning revenue.

A most gratifying increase in the motors connected to the mains has been obtained. In March 1895 only 29½ H.P. was connected; at the present time we have 291⅔ H.P., or in a little over eighteen months the motor H.P. connected has been multiplied by ten. These motors are used for various purposes, such as for lifts and hoists, chaff cutting and corn crushing, printing presses, for driving workshop tools, pumping, and even for revolving hair brushes. A very notable addition has been recently made in the excellent pumping plant of the Bridge Dockyard, belonging to Messrs. Robt. Thompson and Sons. There are two 20-inch centrifugal pumps, each direct coupled to a 60 elec.-H.P. motor, and one 6-inch centrifugal pump for draining, also direct coupled to a motor developing 9 elec.-H.P. The whole plant is condensed into a very small space, is almost noiseless when working at full discharge, and the two large pumps are capable of pumping out the whole dock, containing 1,104,320 gallons of water, in 85 minutes. The current for the whole of this plant is taken from the Corporation's supply mains. Messrs. Thompson and Sons also have installed a 35-H.P. motor for driving the tools in their repairing shops, which is also supplied by the Corporation.

The demand is increasing so rapidly that extra boilers and steam dynamos will be again required for next year. It is the Author's intention to advise the Council to adopt high speed engines with such fly-wheel effect as will enable them to be used equally for traction or lighting requirements, in view of the possible equipment of the tramways in the town for electrical action.

DISCUSSION.

Mr. H. C. Crummack: I should like first to compliment Mr. Rounthwaite on resuscitating the Northern District of the Association. I think it is highly gratifying that after eight years we have again met to visit works and discuss papers. Mr. Rounthwaite makes an apology for this meeting, but I can assure him there is no cause for apology; in fact, we ought to thank him very heartily for the trouble he has taken in arranging this meeting. I hope we shall not again have to wait as long for another meeting in this district. There are many towns where we could be shown works which would be of immense advantage to us. I notice Mr. Taylor says that tarred macadam is a cheap and good pavement for back streets. I have had a good deal of experience with regard to tarred macadam, and I should like to say I would not advise my Corporation to put down that material for back streets. The traffic of those streets is such that tarred macadam would be anything but economical, though for purposes of cleanliness it might be an advantage. For back-street paving there is, in my opinion, nothing so good and cheap as a sett pavement, grouted with asphalt. Mr. Taylor is very strong on the point of random chip pavement. I do hope the days of that rubbishy kind of pavement are at an end. I do not think it has anything to justify its being put down in any way. It appears to me to be a very shoddy kind of pavement, and, so far as "bond" is concerned, is worse in that respect than a rubble wall.

Mr. J. P. Spencer: I can very heartily join in the congratulations which are due to the Authors of the very interesting papers we have heard to-day. I fear there is not very much time for lengthened discussion, and I will follow the example of the first speaker by being very brief and just touching upon one or two points in the papers which have been read. With reference to back streets, I must differ from Mr. Crummack so far as new back streets are concerned. Mr. Crummack evidently cannot be a large owner of property, or he would not so strongly and ruthlessly advocate a sett pavement for back streets, where the owners have to pay for the work as a private improvement.

In the older back streets of large towns, where the work is done at the public cost, and the long-suffering ratepayers are liable, probably it would be more in accordance with modern ideas to adopt a sett paving. Although I say a word or two on behalf of owners of property with respect to the cost of paving, it must not be thought I am an advocate of random chip pavement. In fact, I coincide with Mr. Taylor and Mr. Crummack that it is an unsatisfactory pavement in every respect, except on the one point of cheapness, and probably could only be tolerated where there is a limited amount of carriage and cart traffic, as in back streets. One of its great disadvantages is its noise in connection with the night services, especially in the still hours of the night when the overworked and tired householder hopes to get a little sleep. That brings me to the special recommendation for the use of tarred macadam in back streets. It may not be so lasting, it may form a few hollows here and there on the surface—and even a sett pavement is not free from that—but it has the great advantage of freedom from noise at night. I quite agree with Mr. Taylor when he advocates a sort of cushion or layer of ashes underneath the pavement. That is a very sound recommendation, but here again modern exigencies have to be taken into consideration. We have noticed to-day probably the largest gas engine any of us have yet seen at work, and we are told it is the intention of manufacturers also to use electricity as a motive power; and as a consequence good usable ashes are becoming less every day. We do not despise the use of ashes as a layer for pavement, but we cannot obtain them in large districts, where there is any demand. That is one of the difficulties that would have to be contended with in carrying out Mr. Taylor's suggestion. There is another thing I should like to recommend, in which I may be right or wrong, that is, running the roller over the second course in macadam roads. The slight extra cost of the rolling is amply compensated for by the better consolidation and solidity of the second course. This method of making the road is, of course, more within the means of those authorities who keep steam rollers themselves. It would perhaps be expensive for those who hire to send for the roller for this work, then send it away again and afterwards bring it back to roll the top course. With reference to limestone foundations, they are used mostly under stone pavements and not macadam roads, where hand penning is superior to any other foundation you can have. There are some things to be said in favour of limestone concrete foundations. Each district depends largely upon its own local experience, and lime concrete has been found useful for many things. Not only is it better than nothing at all between the sett pavement and the virgin soil, but it is very useful where you have to take out soft and spongy places. In such cases it forms more of a cushion than you would have with a Portland cement foundation. There is, again, the question of cost. It must be acknowledged that Portland cement concrete is bound to be better than mere lime concrete, though we have, in removing old buildings and disintegrating old foundations, found that lime concrete in the course of years has become a very solid and permanent substance. It not only helps the pavement from settling down, but in certain clayey soils, where the damp is likely to get in, prevents upward risings.

Mr. J. F. SMILLIE: I also wish to express my thanks to the readers of these papers for the care and trouble they have taken in preparing them. I should like first to make a few remarks upon the paper read by Mr. Taylor. And I would add my opinion to those already expressed, that chip pavement is one of the worst kinds of pavement we have; but in certain circumstances chip pavement is superior to ordinary macadam. It becomes entirely a question of cost. If you put aside macadam you are left to choose between chip pavement or sett pavement. It is cheaper than tarred macadam. It is much more durable than the ordinary macadam, and as a choice between the two it is to be preferred. Mr. Taylor says, that tarred macadam is an unrivalled cheap pavement for back streets. Now I do not think that tarred macadam can be a success in back streets where there is much traffic. In back streets the traffic is not distributed over a large area, the wheels go on certain lines, the horses on another, and you get three ruts along the street. The evil which he says is obviated by having back streets paved with tarred macadam is increased by the ruts which are formed by the traffic. With reference to the breaking up of streets by gas and water companies, there is one thing I think should be brought to an end—that is, the ruthless way in which these companies break up our public thoroughfares. I cannot conceive why the law should not be altered, so that gas and water companies should not be allowed to break up our streets in place of the corporation. The sanitary authority is responsible for the condition of the thoroughfares, and the sanitary authority should have the right of breaking up and restoring the streets. If the companies want the streets opened the work should be done by the corporation men at the companies' cost. The companies will not allow you to interefere with their mains, why should they be allowed to interfere with our streets? The work should be done by the sanitary authority. Mr. Taylor refers to a certain limestone kerb which is used on the Tyneside. In my opinion it is the very worst kind of stone that was ever put down on a public thoroughfare; and I would not recommend anybody to adopt it. With regard to cement concrete footpaths, the failures in such footpaths I notice have usually taken place along the centre of the footpath longitudinally. To prevent that I have resorted to a cement runner for the footpath in its weakest part. It has been a conspicuous success. I have not a single crack in any of my foothpaths owing to the support which has been put down the centre of the path. Coming to the other papers, in the first place I congratulate Mr. Snell and Mr. Rounthwaite upon the very fine electric installation they have in Sunderland; but it would be presumptuous in me to criticise those works. I should like, however, to mention a matter which I happened in an incidental way to discover. It is usual to say, indeed it is accepted as a proved fact, that corporations do not manage their affairs nearly so economically as public companies; but it has been customary to compare the works of public authorities with the most successful private undertakings, and not successful and unsuccessful undertakings together. Under the Electric Lighting Act we have an opportunity of comparing the results of the work done by local authorities with the work done by public companies. In the total returns given in the electrical papers we have an opportunity of comparing the cost at which the electrical companies and local authorities produce current. I have totalled the units produced by the private companies in one year, and I find the average cost is 3*d.* I have done the same with those produced at the works belonging to local authorities, and I find the cost is 2·23*d.* per unit, that is, two-thirds of a penny less than that produced by private companies. I find private companies are charging their customers a higher figure on the average than local authorities, and in spite of all this the local authorities are earning the same gross profit as the public companies. The consumers and the ratepayers, therefore, are largely benefited where they have these concerns in their own hands. This is the first time we have had an opportunity of comparing the work of corporations with private companies and the comparison is certainly one very much in favour of the corporation.

Mr. R. S. Rounthwaite: I should like to join my thanks with those of other speakers to Mr. Taylor, for his paper, which is a very interesting one. I should like next to say that this meeting has been called, solely in consequence of your Secretary's persistence. He insisted upon having it, and I gave way. My view is that these meetings ought to be held first in one town and then another. With regard to the question of chip pavements, they are simply horrible. We have 120 miles in Sunderland, and I do not think there is a more expensive pavement or a worse one. You are never done repairing. We have adopted here a random sett pavement, which has proved very cheap and satisfactory. It is laid upon a ballast foundation, and costs 4*s*. 6*d*. or less per yard. A chip pavement does not cost more than 1*s*. per yard less. We have had this pavement laid for front and back streets for nearly twenty years, and the cost of maintenance is remarkably small —very little indeed. With regard to tarred macadam, I cannot say much, as I have not had great experience of it, but I have no doubt it is a most expensive luxury. I have just done a bit of surfacing which cost 2*s*. 3*d*. per super. yard; the same road costs, with ordinary metalling, to maintain, less than 1*d*. per super. yard; and probably another 1*d*. for cleansing; so that tarred macadam, if you get six years' wear out of it, is very much more expensive. Mr. Taylor makes some remarks as to cement footpaths. In Sunderland we use nothing else. Our concrete, however, is laid down on a different system to that described in the paper. We first lay 6 inches of bottoming at least, the first layer of concrete, 1½ inch, is cement and gravel (4 to 1), and the top coat (¾ inch) is granite and cement (2 to 1). This we get laid down for 2*s*. 10*d*. per yard complete, and it is a pavement which has stood very well; some of it is in very good repair to-day, although laid down twenty years ago; and we do not get very much more wear from flagging in streets with similar traffic. Mr. Smillie has made some remarks as to the manner in which he has laid concrete footpaths, and he ascribed his success to a runner support in the centre of the footpath. I do not see how this can prevent cracking; nor how this concrete runner or beam gives any more strength to the path. The cement concrete is laid evenly all over, and I take it that the footpath has a solid support all over it.

Mr. W. **Edson**: I notice Mr. Taylor recommends a thickness of 6 inches for tarred macadam. I should like to ask whether he puts in any foundation or pinning under that. My experience of the repair of tarred macadam is that it is not at all difficult. I have had some experience with it, and find it entirely satisfactory. I was much surprised and sorry to hear that tar from gas-works where they employ very great heats is useless; as I have heard it is intended to put in regenerative furnaces at the Ripon gas-works. If this is so, we shall be at a great disadvantage so far as tarred macadam is concerned. We have used a great deal of tarred macadam, and find it a cheap pavement where the traffic is very heavy.

Mr. T. W. **Stainthorpe**: There are one or two points upon which I should like to say a few words. The first is the question of paving for back streets. My experience is that the best and most sanitary pavement to adopt, so far as my district is concerned, is scoria blocks. The blocks I use are 9 by 4 by 3½ inches. I lay them upon a bed of 2-inch slag 6 inches deep; upon which I put a further 3 inches of fine boiler ashes. The blocks are laid upon this foundation with ½-inch joints, and grouted with Portland cement. Scoria blocks make a very good pavement. I have had some laid thirteen years, and not had a single brick to replace; in fact, the whole street is like one huge flag. The cost is 4*s*. 4*d*. to 4*s*. 6*d*. per super. yard. That is the most cleanly and sanitary pavement for back streets we can obtain. We do not use any natural flags for footpaths, but a composite cement flag manufactured in the district. We not only use these for the main streets but also for the footpaths in rural parts of the district. We can lay these flags for less than 3*s*. a yard. We are doing that rather than use tar asphalt or cheaper material, as with the cost in maintenance it is cheaper in the long run. I would strongly advise my brother surveyors to look into this matter to see if they cannot adopt these composite cement flags, as they are very economical, and also pleasant to walk upon. I quite approve of what Mr. Taylor has said as to the want of roads in the colliery districts of the north of England. Some four or five years ago it fell to my lot to be called in to survey a mining township in Durham, and I found there was not a single inch of properly constructed road in the district. I considered then, and I said when giving evidence before the late Lord Chief Justice Coleridge when the case was tried, that the state of affairs in most colliery villages in Durham was a disgrace to the county and to the century in which we live.

Mr. J. W. **Brown**: I cannot allow the opportunity to pass without saying a few words with reference to random chip pavements. I think random chip pavement in every way is bad. It does not even have economy to recommend it. It is a wasteful pavement. If you do not put in a sound foundation of concrete it will not maintain a passable surface, and it becomes filthy in the extreme in wet weather. The pavement we use in West Hartlepool in back streets is either scoria, or Scotch and Yorkshire whinstones; but the stone we rather give preference to is the Scotch whinstone. It has a better foothold and is a little cheaper than the Yorkshire whinstone. But we have great difficulty in getting a sufficient supply. The difference in price in favour of the scoria over Scotch whinstone is about 9*d.* per yard. I cannot agree with Mr. Stainthorpe as to the advantages of scoria, because we have had a great many broken bricks to take out. No doubt it is a very good form of brick pavement, but in my opinion it is not equal to the natural stone. As to Yorkshire whinstone, we have always had a fear of its becoming slippery, much more slippery than the Scotch, though its life is much longer. The last time I was in your city (Edinburgh) I noticed near the theatre there was a pavement which had become excessively worn and very objectionable. I examined it and came to the conclusion that it was made with setts from Inverkeithing. I am not impressed with these setts for heavy traffic, though it is an admirable sett for back streets. With regard to the use of less noisy materials for back streets, I do not think there should be much noise occurring during the night. I do not think we should have privies to be emptied at night, but there ought to be water-closets and dry ash-pits. I do not believe in the old and pernicious system of accumulating the filth around the houses, but rather favour, after it has passed through our system, letting it at once pass through a system of sewers. With regard to concrete pavement, I find, so far as I have had experience, it is infinitely better in most cases to lay concrete for footpath work in flags than *in situ*. We get a good firm slag in our district, and, that being so, we do not care for the annealing process. When the concrete is in flags we can lay it and get away from the footpaths more quickly, and it is not much more costly than when laid *in situ*. Mr. Taylor refers to granite binding and wearing better than whinstone. We tried several kinds of granite, and had considerable difficulty in keeping a good surface. We can maintain a better and more even surface with Yorkshire whinstone.

Mr. Stainthorpe: The advantages of a flag pavement are considerable over an ordinary *in situ* pavement.

Mr. Brown: I think Sutherland is doing wrong in connection with artisans' dwellings, though it may be following the footsteps of other towns. I think if you have the necessity of erecting artisans' dwellings, it is better to go away from the centre of the town. If it is necessary to abolish a slum district, why not sell the land for the erection of offices and shops, and take your artisans' dwellings further out of the town. The work is undertaken because you have a thickly populated district which must be modified; and to get rid of overcrowding, you erect dwellings which before long will be still more overcrowded. It is far better to get them away from the centre of the town. The more you get these people crowded together, the greater will be the death rate. To pack these people so closely together in buildings three stories high, is directly opposed to your own building regulations. It is certainly opposed to ours, and I hope it is opposed to most others. Then I notice that the division walls between the tenants are only 4½ inches thick. We should not allow a private owner to do that. Then why should a municipality do it? Then I see you have to enter the water-closet through the scullery. That is very objectionable where there are fires, hot water and drains, and should be strongly condemned. Then I think, in re-erecting this class of dwelling, there should be ground provided at the back, and that each house should be self contained, instead of driving the children on to the roofs to play. Any money the corporation have to spare from the sale of the valuable central sites might be spent in subsidising a tramway or light railway to provide cheap fares for workmen who have been provided with houses in the more healthy suburbs.

The votes of thanks to the Authors of the papers having been accorded with acclamation,

Mr. H. W. **Taylor**, in reply, said: I have to thank you for the kindly way in which you have received my paper. I am glad to find that the consensus of opinion among those who have taken part in the discussion with regard to random class pavement, is that it is unsatisfactory. It is a very poor pavement and excessively noisy. I have lived in Newcastle in a street where the front and back of the house is paved with chips, and a night-cart passing at a slow rate never fails to announce itself at 50 yards distant. I am glad to find there is an alternative to chip pavement in the form of a random sett pavement laid on ballast. I should like to have some fuller particulars from Mr. Rounthwaite of this kind of pavement. Mr. Stainthorpe also mentions scoria bricks as an alternative. I believe they are good and sanitary, but I am afraid they have the disadvantage of becoming slippery.

Mr. **Stainthorpe**: That is my experience. Scoria bricks have been used for crossings, and we have had to take them up because they are slippery. With regard to tarred macadam, which has been a debatable point of the paper, I have used it in back streets for several years, and am quite satisfied with it. A great deal depends upon the manner in which the tar is mixed with the macadam; and, unless you use care and properly consolidate the material, difficulties will be found to exist. Of course I have spoken of the use of tarred macadam on a fairly wide back street. With a carriage way of 18 feet wide, the traffic is not so confined as in a back street with a carriage-way of 10 or 12 feet width only. Of course a sett pavement with bitumen joints is very nice, but it has the disadvantage of being costly.

Mr. **Crummack**: I am putting it down for 4*s.* 6*d.* a yard.

Mr. **Taylor**: That is cheap; usually a sett pavement comes to something like double that amount. I can quite bear out the statements which have been made as to flags. I consider that artificial flags are far superior to *in situ* work. Flags have the advantage that you can use them at any time of the year. I have used the annealed flags, and they make a very satisfactory footpath. We can lay them in the Newcastle district at 3*s.* 8*d.* per yard; while the ordinary *in situ* work costs 3*s.* per yard.

Mr. Rounthwaite, in reply, said: The only gentleman who has touched upon my paper is Mr. Brown. He refers to the general question of overcrowding, and to the taking of people back into a district which has been cleared. I quite agree with him in principle; but each case must be taken on its merits. It is a difficult thing to clear a portion of a town and send the population away to the outskirts, especially where you have your docks and large works immediately adjacent, and where provision must be made near to them for the labouring classes. The labourers who are employed at the docks would not go three miles away, they would huddle into other buildings close by, and overcrowd them. (Mr. Brown: Pull them down.) That is very nice in theory, but it is not practicable. The plans do not contravene any bye-law, as Mr. Brown suggests. Had this been a private speculation it would have been perfectly competent for the purchaser to pull down the property and rebuild it up to the street line. You could not prevent him doing that unless you purchased the property. I have just been glancing at the plans, and in two blocks the whole of the party walls are shown to be 9 inches. On the others several of the walls are shown as only 4½ inches. I do not think that is desirable. There will be no spare money for schemes to subsidise tramways or light railways. If the scheme pays its way, that will be all.

Mr. Snell: I have nothing to say except to thank you for the kind way in which you have received the paper, and also for allowing me to read it before your Association.

The Members attending the meeting, having been entertained to luncheon by Mr. Rounthwaite, proceeded by tramcar to Rooker for the purpose of inspecting the important Harbour Works which are in progress there. On arrival at the Harbour Works, the Members were received by Mr. Smith, assistant engineer, and Mr. Wake, jun., who, in the unavoidable absence of Mr. Wake, Engineer to the River Weir Commissioners, acted as guides to the party and explained the various works in progress. The concrete and block-making plant were shown, and the system adopted of manufacturing and laying the huge concrete blocks explained by

Mr. Smith. The Members were also afforded an opportunity of seeing the installations of large gas engines in connection with the pumping machinery at the graving dock. At the conclusion of the inspection of the works, a hearty vote of thanks was accorded to Mr. Smith and Mr. Wade, jun., for their kindness in receiving the Members and conducting them over the works. The Members next visited the Borough Electricity Generating Station, Mr. Snell, engineer in charge, met the Members at the works and acted as guide, explaining the various points of interest in the electrical machinery and the construction of the works. From the electricity works the Members were taken to the Corporation Baths, which were erected from the designs of Mr. Rounthwaite. The Baths, comprising excellent swimming and slipper baths and wash-houses, are considered to be amongst the most complete and best arranged in the North of England.

In the evening the Members dined together at the Grand Hotel, Sunderland.

DISTRICT MEETING AT WESTMINSTER.

February 18, 1898.

Held at the Institution of Civil Engineers,
Great George Street, S.W.

C. H. Lowe, M. Inst. C.E., Vice-President, *in the Chair.*

Mr. G. R. W. **Wheeler** was unanimously re-elected Honorary Secretary for the Metropolitan District.

The following subjects were discussed:—

(*a*) The proposed Bill to extend the provisions of the Poor Law Officers' Superannuation Act, 1896, to the officers and servants of other local authorities.

(*b*) The proposed Bill to amend the Metropolitan Officers' Superannuation Act, 1866.

(*c*) The proposed Bill to amend the Metropolitan Management Act, with respect to sewers and drains.

(*d*) The proposed conference of Metropolitan Surveyors called to consider the question of Sewer Ventilation.

(*e*) The collection of house refuse from blocks of flats.

Mr. W. **Weaver**: Mr. Chairman and Gentlemen, I do not propose to inflict too much of myself upon the meeting in relation to this first subject, because I shall, possibly, have more to say upon the second subject on the agenda. There are now two Bills before the current session of Parliament, dealing with the superannuation of officers serving local bodies. The first is the Local Officers' Superannuation Bill, which is introduced under the auspices of the Local Government Officers'

Association, and applies to the whole of the country, including the metropolis; and it proposes to make all officers and servants appointed by any board (other than those dealt with by the Act of 1896) entitled to a Superannuation allowance computed in accordance with the terms of the Superannuation Act of 1866. One of the important points in the Bill is, that it reckons all service under public bodies as continuous service. That is to say, if a surveyor served one board for ten years, and then transferred himself to another board for another series of years, and again transferred himself to a third board, his services under all the boards are reckoned as continuous in calculating his pension. This is the important point in this particular Bill, distinguishing it from the second Bill—the Metropolitan Officers' Superannuation Bill, which is promoted by the Metropolitan Officers' Association. It is a very short and simple measure, seeking to convert the word "may" in the Metropolitan Officers' Superannuation Act of 1866, into the word "shall" under the Act of 1866. The vestry of any parish or the district board may, at their discretion, grant to any officer in their service, a superannuation allowance, and this Bill proposes to make that section to read, "that the vestry of any parish or district board *shall* grant to any officer in their service a superannuation allowance." I think it will be admitted that in passing the Act of 1866, it was the intention of the Legislature to make it compulsory upon the local authority to give a pension if the officer had not forfeited his right to it by some misconduct; but in giving that discretionary power, the exercise of it has led to a number of what may be termed abuses in its application. Within the knowledge of many of us, officers who have served local bodies for very long periods, have, at the end of their service, had to retire without any compensation whatever, owing, possibly, to some radical change in the body, or the policy of the body they served. I do not think the Legislature intended that, when they made this section of the Act permissive. I may say here, that the Metropolitan Officers' Superannuation Act applies only to the metropolis. Under both the Bills there is a schedule—alike in both Bills—of contributions from the officers. According to that schedule, an officer who has served less than five years has to contribute 2 per cent. of his salary to a fund; an officer who has served more than five and less than fifteen years has to contribute 2½ per cent.; and in the the case of an officer of more than fifteen years' service, 3 per cent. of his salary towards this fund. It is supposed that after a few years this fund so constituted will be sufficient to provide the superannuation which will have to be drawn upon it, and that prospect, apparently, is borne out by the actuarial calculations which have been made, and are tendered in support of the Bill. The first Bill, which applies to the whole of the country, including the metropolis, has been considered by the Council of our Association, and they came to the conclusion, that owing to the extended scope of the Bill, and that it is applicable to all officers and servants of any board, there is not the slightest chance of its passing through the Legislature, and therefore they withdrew our delegates from the conference on the Bill, after handing in a cheque towards the expenses of the proceedings. Of course this Association—of which this District Meeting is a portion—would be only too glad to find the benefits of superannuation extended to the whole of the officers throughout the country, but at the same time, if we are of opinion that there is no chance of this Bill going through, while there is a good chance of the smaller Bill going through, we should be unwise to wreck the smaller Bill on the remote chance of getting the larger Bill through. It appears to me this is one of the crucial points the meeting ought to consider, whether we are to confine our exertions to the support of the smaller Bill, or whether we will support the larger Bill. Of course, we do not want the Association at large to twit the metropolitan portion of it with selfishness, and with sinking the interests of the entire Association for their own benefit; but at the same time we have got to consider what is the best way to go to work in regard to these two measures. I threw out a suggestion at the last meeting of our General Purposes Committee, that what we are proposing to do by the Metropolitan Bill might be done by a short clause in the new Bill for the reform of London Government; and Mr. Barber has undertaken to bring that suggestion before the proper quarter, but, unfortunately, he has a committee meeting to attend this evening and cannot be present to state how the matter stands. If we could only get a clause in that Bill, we might obtain everything we require without pressing a separate Bill through Parliament. If this Bill does get before the Committee of the House of Commons, or if this suggested clause is inserted in the Bill for the Reform of London Government, and it comes before the Committee of the House, there is no doubt evidence will have to be tendered in support of our claim to superannuation; and it would be a good plan if any Member of the Association who knows of any case of unjust treatment of an officer with regard to pension, would put the details of the case in writing, and send it to Mr. Cole, the Secretary, to be docketed ready for the use of any member of the Association who may be put forward to give evidence in support of the Bill. I recollect when the Royal Commission on the Unification of London was sitting, I gave evidence on behalf of this Association, and I need hardly tell you I was very careful to press upon the Commission this question of superannuation. I told the Commission it was within my knowledge that several surveyors had, at the end of a long official life, been thrust out upon the world without any provision whatever for their old age, owing to some radical change in the constitution of the board which they served. The chairman of the Commission asked me if I was prepared to give cases, and I had to rely upon my memory for cases which I could cite on the spur of the moment. Therefore, I say, it would be a good plan if we could have tabulated specific cases of harsh treatment to put forward; and any Member who knows of such cases might send details to Mr. Cole. I mean not only cases of men going altogether without a pension at the end of a long period of service, but also cases where a retiring borough engineer has been appointed by his board consulting engineer, an appointment which has been regarded as a pension for his past services, and then, in a few years, his services as consulting engineer have been dispensed with. Cases of that description would also bear upon the point which I have in my mind. By-the-by, I have not said anything as to the extended scope of the Local Officers' Superannuation Bill. It applies to all officers in the service of a local authority, that is interpreted to mean, anyone appointed by a resolution of the board. Of course, it could be argued that the scavengers were servants of the board. It only wants a certain element in the representation to be in a majority on the board, for the board to appoint all their scavengers by resolution, when, under this Bill, they would all be entitled to a pension. That would place the surveyor in a very difficult position, as one would naturally hesitate to discharge a man at a day's notice if you knew you were depriving him of his provision for old age. Having touched upon all the salient points of the two measures, I will leave the question to the meeting to deal with, particularly as to whether we shall send a resolution to the meeting of the Council to-morrow as to what is the opinion of the meeting. Probably, the feeling of the meeting will be to support the larger measure, so long as there is any chance of its going through Parliament; and, in default of that, to press forward the smaller measure to the best of our ability.

Mr. J. PRICE: It was with some surprise that I heard what Mr. Weaver said about the rivalry between these two Bills. I should have thought at a Metropolitan District Meeting they would have simply considered the Metropolitan Bill, leaving the wider Bill for the consideration of the general body of the Association. At present it appears to me if you are going to deal with the General Superannuation Bill, it is a matter for a general meeting of the Association, and not for a district meeting. I am convinced that in any way to raise a feeling of rivalry between the propositions set forth here as A and B, is not in accordance with the feelings of the Members of the Association as a whole. I wish to say this straight away, before dealing with the question of superannuation, because Mr. Weaver anticipated the word "selfishness" might be used if this proposition was pressed forward. I suppose the question is one which has to come before the Council of the Association.

Mr. WEAVER: No, it has been before the Council.

Mr. PRICE: I think the metropolitan officers are fairly entitled to what they ask for in their Bill; but, on the other hand, I think that every Member of the Association would welcome a Bill somewhat on the lines of the Local Authorities Officers' Superannuation Bill. Last year the Birmingham Corporation had a Bill passed through Parliament somewhat on the lines of this Bill, but in some particulars not quite so good a Bill as this. In Birmingham, an officer contributes 3 per cent. of his salary, and has to retire at sixty-five. Any officer who is in receipt of a salary of 500*l.* a year or over, can only get a maximum of thirty-sixtieths, or one-half of this average salary received during his last five years' service, whereas any official receiving a salary under 500*l.* can receive a pension up to two-thirds of his average salary. This is making fish of one and flesh of another. It is, indeed, most unfair to make such a difference between two classes of officials. In Liverpool, they have the best Superannuation Act of any municipality, because it is based on fiftieths instead of sixtieths, and allows a maximum pension of thirty-fiftieths, with retirement at sixty years of age. The same payment is made to the fund, viz. 3 per cent. I am much interested in clause 4 of the Local Authorities' Superannuation Bill, whereby service under different municipalities is counted as continuous for superannuation. I have been connected not only with Birmingham, but with other authorities where there were no superannuation schemes, and if that clause became law, I should be in a position to count twenty years' service, whereas at the present time, I am not able to count more than eighteen months. The Bill, on the whole, is so plain and straightforward as hardly to call for any special comment. I hope in any expression of opinion there will not be any question of rivalry between the two Bills, but that Members will show that both Bills are necessary to be carried forward in the interest of the general body of Members of the Association.

Mr. W. N. BLAIR: I should like to say one or two words which I think may harmonise to some extent the ideas of Mr. Weaver and those of Mr. Price. Mr. Weaver looks upon this Metropolitan Bill in the light of the old adage, that "half a loaf is better than no bread." If you cannot get the bigger Bill applicable to the whole country passed, get the smaller Bill. Let us support the larger Bill, so long as there is any hope left of its passing, but, failing that, we have the other Bill to fall back upon. As to the merits of the two Bills, I believe they are equal; they are different only as to the extent of their application, but the same as to their effect on individuals.

Mr. W. A. DAVIES: I should like to ask if the Metropolitan Bill, altering "may" into "shall," could not be amended by making it apply to the whole of the authorities' officials?

If that cannot be done, I think the Association, as a whole, ought to use their most strenuous efforts to get the Local Authorities' Superannuation Bill passed into law. I do not think the fact of the wider Bill being pushed would destroy the small amending Bill for the Metropolitan officers. If it is right for the Metropolitan Bill to be amended, surely it ought to be right for the principle to be extended to every officer holding a similar position in any part of the country. I think, from my point of view, that support to the wider Bill instead of wrecking the smaller Bill would tend to support it. I hope the Council will resolve to support both these Bills.

Mr. R. Read: I rise to support the remarks of Mr. Price. As a provincial Member, I think what is sauce for the goose ought to be sauce for the gander, and any Bill supported by the Association ought to be for the benefit of the whole body. It is a very important matter, especially for those who have been officers for many years. I have been in office something like twenty years, and am approaching the time when a superannuation scheme would be of advantage to me. I think a superannuation scheme merely for the Metropolitan District would be a very inadequate way of meeting the question.

Mr. H. J. Marten: I think it would really be better for the metropolitan officers if the wider Bill could be passed, as a great many of us who have served in provincial towns would then have our previous service reckoned for superannuation purposes. I think, however, that the provincial Members forget that metropolitan officers are now, under the Act of 1866, entitled to a pension, and that our salaries are to a certain extent based upon that expectation; therefore, the Metropolitan Bill ought to be pushed in any case.

The Chairman: I think this meeting may very well support both these Bills. The metropolitan officials are supporting this smaller Bill because it is simply to amend a permissive Act, which is already on the statute book, and would make the granting of a pension compulsory on the metropolitan authorities, together with contributions for officials on the scale as provided. The metropolitan officers do not wish to do anything which would appear to be in any way selfish, and are prepared to give the same support to the wider Bill which proposes to make superannuation general throughout the country. We are very much indebted to Mr. Weaver for the lucid manner in which he has explained both Bills to us, and if some gentleman would now propose a resolution defining the course which should be taken, it could go before the meeting of the Council to-morrow, and would strengthen their hands in any decision they may arrive at.

Mr. **Weaver**: My view of the matter would be that the Council of the Association should be requested to support both Bills, giving preference to the Bill with the larger scope, so long as there is any chance of its going forward, and in the event of the Council seeing there is no chance of the larger Bill going forward, to concentrate their efforts upon the smaller measure. We were rather of opinion in the Council, that there was not much chance of the larger measure going forward, as far as we could learn. Efforts are being made to push it forward, and there may be a greater prospect of success by-and-by, than there was when the Council considered it some months back. If there is any chance of success, let us push forward the larger measure, which will do the greater good for the greater number, but if there is no chance of doing that, let us use our influence as a lever to push forward the smaller measure.

Mr. **Price**: I will propose that this meeting do hereby support both Bills referred to in sections (*a*) and (*b*) of this agenda paper.

Mr. W. A. **Davies**: I shall be very pleased to second the resolution. I hope the Council of this Association will push the Local Officers' Superannuation Bill as strongly as they can, because I think if the Metropolitan Bill was not pushed through Parliament this session it would not be a very serious matter. The metropolitan authorities have power to give superannuation; and sometimes the word "may" has been construed to mean "shall."

The **Chairman**: I think the matter has been pretty well threshed out by the meetings which have been held, and also by our own Council.

Mr. Price's proposition was then submitted to the meeting, and adopted unanimously.

Mr. W. N. **Blair** introduced the question of the proposed Bill to amend the Metropolis Management Acts, with respect to sewers and drains. He said: I think the only thing to be said is to point out the difference between the Bill of this session and the previous Bills on the same subject. Shortly, the Bills which have hitherto been drafted were all intended to revert back to what we formerly considered to be the law with regard to combined drainage. Until five or six years ago, we thought all combined drains were under the responsibility of the owners, and not vested in the local authority. That interpretation is to be preserved by the present Bill with this exception: "provided that the London County Council may at any time hereafter approve as a sewer, any drains for draining a group or block of houses where, in the opinion of the local authority of the district, it is desirable that such drain shall be cleansed, repaired, and maintained at the expense of the local authority, and such drain shall thereupon become a sewer, and be vested in the local authority." I may explain that that provision has been put into the present Bill, really to try and escape the opposition of Mr. Boulnois, M.P., on behalf of the Marylebone Vestry. The opposition to the original Bill has been most strenuously maintained by the vestry of Marylebone, and that provision has been put in with the hope of preventing them opposing it this session. With this provision in, I believe there is every prospect of the Bill being carried through. It is true there will be strong opposition on behalf of the owners of property, who are beginning to realise what an economy it is to them that these combined drains should be handed over to the local authority. Everybody is wide awake now to the belief that if only two houses are drained into one drain, that then it can be handed over to the local authority to maintain. We have to spend thousands of pounds a year in this particular work. Owners know that, and will be very loth to undertake the burden they ought to bear, but I do not think vested interests of that kind will induce Parliament to withhold what is so manifestly a justifiable Act. I do not think it will relieve municipal officers of any of the trouble—that is of the actual work of seeing that the necessary work is done—but it will relieve the local authorities of the expense of the work.

Mr. T. W. E. **Higgins**: If this Bill passes, will these combined drains be private drains, or will they be sewers for which the local authority will be responsible?

The **Chairman**: They will remain drains if done under a sealed order of the vestry, as provided in the Metropolitan Management Acts. There are many drains which have not been constructed under any order of the vestry, but have been surreptitiously connected with the sewer. If an order has been made under the seal of the vestry, there can be no difficulty in treating them as private drains.

Mr. **Higgins**: If no order has been made, they will become sewers?

The **Chairman**: They will remain private drains if an order has been made; without such order they become sewers, repairable by the local authority.

Mr. **Blair**: It should be understood that this Bill is retrospective. It applies to all existing combined drains as well as any laid in the future.

Mr. **Lewis Angell**: I am much troubled with this question of combined drainage, as you all know, and of course, wish Mr. Blair success in the realisation of his hopes, but I am afraid he is doomed to disappointment. I think there is very little prospect of this Bill getting through the House of Commons. I was the first to bring the subject before the Association, and my Council, through the Town Clerk, has circularised the authorities of the whole country to move in the matter. As you know, the Association of Municipal Corporations has also endeavoured to help in the matter, but nothing has been accomplished. The Bill has been always blocked, because, as Mr. Blair has said, it is very much in the interests of property owners that things should remain as they are. In my own district, which in the early days abnormally increased without sufficient supervision, hundreds of miles of very imperfect private drains were laid, which are now falling to us to repair. It would be very much to the public interest if the Bill were passed, but I very much doubt if it will be.

The **Chairman**: There is no resolution necessary upon this subject. The difficulty we are labouring under with respect to combined drainage is pretty well understood by all metropolitan Members.

The **Chairman** then introduced the question of "The proposed conference of Metropolitan Surveyors called to consider the question of sewer ventilation." He said: I was very anxious this question should be brought before the Association, because this day week (the 25th of February) the surveyors and, I understand, some of the medical officers of the metropolis, will meet in conference under our President (Sir Alexander Binnie). It is very essential, if possible, we should agree upon some broad views on this particular subject. The question is a very vexed one, and it is almost impossible to be able to generalise or lay down rules that will apply to all districts alike; what, for instance, would apply to Shoreditch will not apply to Hampstead, and so on. That is our difficulty in coming to any decision; but we are all very anxious that some practical result should come from our meeting on Friday next. We want to guard against such a trouble as we were put to by the 1891 Public Health Act, when, owing to the influence of our friends the medical officers of health, a little clause was put in as to snow clearing, which has turned out to be totally impracticable. It is possible some of the medical officers will promulgate theories, with which we, as surveyors, will probably have very little sympathy, although, of course, we are all actuated with the wish to do what is best for all London. I think, possibly, there is no district in London, certainly no suburban district, which has given more attention to this question than my own. We lie particularly high, and the theory was started that we were suffering unduly from the up current from the main sewer of London. That theory was started in 1877, and was backed up by complaints both sentimental and real. I do not think anyone here will dispute my statement, that one would rather deal with twelve real complaints than with one sentimental complaint. Upcast shafts were tried with and without gas, with patent revolving cowls as extractors, and open mouths without any cowls. We tried numerous plans to get rid of this sewer air. Our main lines of sewers were dealt with by placing reflux traps or flaps to prevent the up-draught from London, and we went so far as to syphon some of the sewers. This thing went on until 1886, when, as we were still troubled by complaints, the Vestry called in Mr. Mansergh, one of the highest authorities of the present day, to advise them on the whole matter. Mr. Mansergh went thoroughly into the matter and examined many of the sewers of Hampstead, and reported they were generally in excellent condition, properly laid, with ample falls, and the only thing he could suggest, as the final result of his report was, that there was a little more automatic flushing required, and that there certainly should be more open ventilation. Mr. Mansergh recommended open ventilators in the roads, with gratings of sixty square inches superficial open area, and that the ventilators should not be further apart than sixty yards. Since that time the Vestry has pretty well followed out Mr. Mansergh's recommendations. They have spent a large amount of money, 2000*l.* or 3000*l.*, in supplying automatic flushing tanks, and in providing an additional number of ventilators in various parts of the district. After carrying out these works, and upon careful examination and testing, we think we have discovered the source of the frequent complaints; and it is a curious result to notice, that complaints are much more general in the districts where the modern system of house drains has been established under the new bye-laws of the London County Council, than in the districts where the old system of drainage remains, and the sewage matter is at once taken direct to the main sewer and not held in suspension in traps, examination chambers and the like. We have localised the complaints so far that we are in a position to say that the manholes and the intercepting traps do not properly clear themselves. There is a certain amount of sediment left nearly at all times, which is not discharged for a considerable period, possibly for some days, and in some cases it may be even for weeks. In some cases, where the syphon becomes virtually blocked, the solid matter accumulates, and there is practically a high-water mark round the brickwork in the chambers showing where it has stood. The men working in the sewers say that from eight to eleven in the morning, when the housemaids are generally busy cleaning out the whole of the bath establishments, &c., in large houses, the smells which are given off in all directions in the sewers are so abominable that they are almost unable to stay in them. We have thus been able to so far fix the complaints as to be able to suggest to householders and builders that really what is required on their drains is simply extra means for keeping clean and flushing. The waste water preventer is an abomination, as there can be no proper flush of the pan or closet. You want to supplement that by flushing the drains themselves at frequent intervals by means of flushing tanks constructed at the highest points of the house-drainage system. My board has gone carefully into the matter, and arrived at the conclusion that the proper plan is to flush the sewers regularly well where required, and also to provide additional open ventilators, and I may say that where the complaints have been dealt with recently in that way, and extra ventilators have been put in, the complaints have ceased to be made. The additional ventilators no doubt diffuse the sewer airs, and so lessen the effect on any given spot; and, as a consequence, we are not troubled with so many complaints. The old drains in my district, as in other parishes, are being remedied as fast as they can be; and I have no doubt, if we go on as we have been doing, increasing the ventilation of the public sewers, and can induce owners of property to increase the flushing of the private house drains so as to keep them clear, we shall find there are fewer complaints of smells from open ventilators in the streets. As far as the Hampstead district is concerned, the death rate has not gone up, which is pretty conclusive proof that the steps now being taken are in the right direction. If we can possibly come to some consensus of opinion as to what is the best thing to be done, it will fortify and strengthen our influence very much when we come before the Conference on Friday next. Personally, I have not much confidence in conferences, because we do not generally come to very practical conclusions; but I do hope we shall so thresh the subject out to-night as to help us to arrive at some practical result. Mr. Weaver has furnished me with a copy of his report on Sewer Ventilation, &c., in which he states that, in his opinion, the introduction of intercepting traps is the cause of all the trouble. In favour of free and open ventilation, I see Mr. Weaver quotes two very high authorities on the subject, viz. Dr. Simon, late Medical Officer to the Privy Council, who assured him that he was strongly in favour of free diffusion of sewer air, as against its concentration in the sewers; and also Dr. M. Kirchener, of Stuttgart, who in 1816 wrote as follows: "A distinction is drawn between sewer air and sewer gas, and it is pointed out that the latter can only form in sewers which contain dead air, and in other places where effective ventilation is wanting. In well-constructed sewers the contents pass away freely and rapidly without undergoing putrefaction, and the air in such sewers is in no way *unhealthy*. The house drains and soil pipes are much more likely to engender evil smelling and injurious gases than are the sewers." I do not consider that pipe ventilators put up in my district have been by any means a success. I have rarely found any satisfactory action going on in the pipes; no doubt these pipes are an easy way for the surveyor to get out of a difficulty. He receives a complaint of smells from an open ventilator, which he blocks up, substituting for it a pipe ventilator, and often the only result is that additional pressure is put on the nearest surface ventilator. So far as my district is concerned, the upright pipe ventilators have not been generally a success, either with or without gas, or with or without cowls.

Mr. J. P. **Norrington**: I want to have it stated distinctly whether the practice of putting in additional surface ventilators has stopped the complaints?

The **Chairman**: Yes, it has stopped the complaints.

Mr. **Pritchard**: In many cases?

The **Chairman**: Yes.

Mr. **Weaver**: I should like to inform the meeting how the matter comes before them this evening. During the autumn of last year, my esteemed colleague the medical officer of health of Kensington presented his annual standing dish to our sanitary committee, of the stinks in the parish. He does that regularly once a year. (Mr. **Pritchard**: They all do.) I was called upon to reply to the remarks which he made to the sanitary committee, and I told the committee I was fully sensible of the debt of gratitude I owed to the medical officer for giving me an opportunity to make some remarks upon an evil which he had so largely contributed to create. I think the growing complaint of smells in the public highways, without doubt, are in a large measure to be attributed to the advance of sanitation in the houses. I informed my committee that if they desired me to go fully into the matter, I would give them a report on the subject, as I had done in previous years. The result was I gave the report dated the 18th of

October of last year. One suggestion in that report was that I recommended my Board to send a communication to the London County Council, asking them to call a conference of the various metropolitan surveyors to thresh out this question, assisted by the Chief Engineer of the Council, Sir Alexander Binnie. The communication was accordingly sent to the London County Council, and it was promptly acceded to by the Council, with the result that Sir Alexander Binnie has appointed this day week at Spring Gardens for the metropolitan surveyors to meet and confer with him. At the same time the medical officers of health have, I think, in some districts, been appointed as delegates to the meeting. Well, you will clearly see if there is an equal number of medical officers and of surveyors at that Conference, if there is any very great diversity of opinion amongst the surveyors they will be entirely outvoted and sat upon by the medical officers, who will have, I should say, a pretty solid unanimity of opinion upon the subject. The medical officers in their language will say: make each house perfect, and let the public authority deal with the public sewers. That is very good in theory, and it shifts the burden of responsibility entirely off the shoulders of the medical officers to the shoulders of the surveyors. It was with a view to this Conference threshing out the subject, and arriving at something like unanimity amongst ourselves, that the Council and the District Secretary thought it advisable to place it on the agenda paper for this meeting, so that if possible we might thresh it out and adjust any differences amongst ourselves. When syphon traps began to be introduced into London, I ventured to express the opinion, and supported it in a paper which was read and discussed for two evenings before the Medical Officers' Association, that the introduction of syphon traps into main house drains was bad in theory, and would have a bad result in practice; and the subsequent experience which I have gained since reading that paper has only tended to confirm the opinion I then expressed. It seems to me that smells in the street increase in direct proportion and ratio to the reconstruction on modern principles of house drains. In former years each house in a measure aided to get rid of the smells in the sewers, whereas now each house strives to shut off all connection with the sewer air, and thrusts its smells under the nose of its neighbour. I think each house drain ought to aid in the diffusion of the smell it helps to create; that the drains of the houses and the sewers in the public highway should all be treated as part of one system, like the veins and arteries of the human body, dependent upon one another and assisting one another. In view of this Conference next Friday, I have taken the liberty of sending to each of my metropolitan brethren a copy of the report I have presented to my Board, and in a circular letter, which I have sent with that report, I have asked you to consider the views I have put forward, and if, after consideration, you can support the resolution which I propose to move at that Conference, or something like it, it is possible our opinion may have some weight at the Conference; otherwise, if there are forty of us there and we have about thirty different opinions, our views will have very little weight with the authorities. Of course, as you know, under the present statute each drain is required to be ventilated; but in modern practice the ventilation of a drain is only partially carried out, as the ventilator only ventilates that portion of the drain between the intercepting traps in the front and its termination at the higher end. I maintain that only a portion of the drain is ventilated, and that the length of drain between the sewer and the intercepting trap is not ventilated in any way. If the County Council under its new bye-laws, insists upon an intercepting trap in the front of each house, I propose that a ventilating pipe shall be carried up on the sewer side of the interceptor. If there is no intercepting trap, then of course the ventilator at the end of the drain would answer all practical purposes. There is one other point which I do not refer to in my printed report, but is included in the resolution which I wish to move, that where an intercepting trap is placed on the main line of a house drain, a flap trap should not be fixed on the outlet of the drain, except in special cases where directed by the local authority; that would be in such cases where there is a risk of flooding, so as to prevent back flow from the sewer. At the present time, on an average, I unstop about twenty drains a week, and almost the unvarying report of the sewer men is that the syphon trap is choked with grease, or that there is an accumulation of fat behind the flap trap, which the flow of the drain, owing to its being so diminished in force by passing through the interceptor, has not had sufficient power to force into the sewer. In a great number of cases, at the request of the owners, I have removed the flap traps altogether, or fastened the flaps up to the sewer. To meet the further evil which exists where interceptors have been fixed on the drains throughout a district, I propose that the local authority be armed with powers to carry ventilating pipes up buildings wherever they deem it necessary for the ventilation of the sewers. I fix a number of these pipes annually, as directly I receive a complaint of an offensive ventilator, I enter into correspondence with the owners and persons interested in the property in order to get the necessary permission to carry up a pipe, and perhaps, after writing half a dozen letters, I get some to consent, and others refuse; in about 50 per cent. of the cases I meet with success, and in the remaining 50 per cent. my efforts are fruitless, and the street ventilator has to remain or an order is made to close it up. With regard to one point touched upon by Mr. Lowe, and emphasised by Mr. Norrington, that the multiplication of ventilators leads to a cessation of complaints, that is not quite my experience. In some cases it does lead to a discontinuance of complaints, but in many other cases I have found the complaints are visionary; and very often the existence of a ventilator opposite a man's house is sufficient ground for him to complain of its existence, and not because there is any smell therefrom. I have several recorded cases in my books where I have quietly closed ventilators underneath, and have received stronger complaints after they have been so closed, and I know of several surveyors who have had similar experiences. I should look to a multiplication of ventilators to lead to a multiplication of complaints. Then the increase of ventilators at the street surfaces would lead to a lot of road sweepings being forced down into the sewers and forming little dams on their inverts and retarding the flow of sewage. Of course, buckets could be placed underneath to catch these sweepings, but that means extra trouble to empty the buckets, particularly where you have many miles of roads to attend to. I think the simpler plan would be to make each house put up a pipe. At Buenos Ayres, which I consider has one of the most perfect systems of sewerage and drainage, each house is required to carry up a ventilating pipe from the sewer side of the interceptor; at Torquay, likewise, a place where you go if you want to prolong your life, the pipes are carried up the fronts of the houses. I do not wish to occupy too much time, but I would impress upon the metropolitan members this important fact. I want if possible that the surveyors of the different authorities in London should have some little voice in the guidance of the affairs of London, and we can only obtain that by pulling together. If we can go to that meeting next Friday fairly unanimous, I think we shall do some good. I do not recommend the adoption of special ventilating columns, of which there are several in the market; these columns all mean extra expense, and I always endeavour to keep down the rates rather than increase them. In this particular matter I think the duty of the householder is to help in getting rid of the smells which the householder creates, and not that the public rates should be burdened either by the erection of columns with gas burning or with exhaust fans, because whatever effect they had upon the sewers, they would certainly have the effect of increasing the rates.

Mr. J. P. **Norrington**: I am afraid I am not going to show that unanimity which Mr. Weaver has assured us is so desirable, as I do not agree with him on this matter. I was very pleased to hear from Mr. Lowe that his Board had adopted the advice given them by Mr. Mansergh, and had constructed surface ventilators about 60 yards apart. That was the recommendation of the Metropolitan Board of Works in 1886, and it was afterwards emphasised by them about 1887 in a report which Mr. Weaver refers to in his report to the Kensington Vestry. On page 10, paragraph 10, of Mr. Weaver's report the recommendations are quoted as follows: "That the surface ventilators to the recently constructed sewers have ordinarily been placed at a distance of from 50 to 60 yards apart with air openings in the gratings equal to 60 square inches, and that the number and size of many of the ventilators on other sewers in the Metropolis should be increased." Then the recommendation goes on to say, "That the amount of ventilation afforded by large special ventilating shafts is in no way commensurate with their cost, and that the adoption of such shafts, with or without fire heat, or the connection of sewers with factory shafts, can only be adopted in very exceptional circumstances. Where shafts with fire are used, the sewer gases should be allowed to pass into such shafts over, as well as through the fires, otherwise the amount of ventilation afforded will be very much limited." Some time ago I made experiments as to the value of ventilating shafts, and the facts I ascertained were unfavourable to their use. I wish to urge the surveyors who are present to make experiments for themselves before attending the Conference on Friday next, and I think that if such experiments are made my opinion will receive a great deal of support. The figures I propose to lay before the meeting are the result of tests made by myself in 1894, and they were published in the 'Surveyor' of December 28th, 1894. My attention was called to the matter by the report of the Borough Surveyor of Leicester, which appeared to me to be one with which I could not agree. The tests were very carefully made, and the result of a trial of 26 surface ventilators was that without any exception they acted more or less vigorously, the average result being that 43 cubic feet of air per minute, or 2580 cubic feet per hour, passed in or out of the sewers. I examined at the same time, and under the same conditions, 12 ventilating shafts, some of which had been erected by the London County Council and some by my Vestry. I am sorry to say of those shafts only three showed the slightest movement. In two cases I considered that the air in the sewer was under pressure, and the shafts were acting as a kind of safety valve. But in any case only three acted, and the net result was that only 4·25 cubic feet of air per minute, or 255 cubic feet per hour, passed through them; I call that a very insignificant and deplorable result.

Mr. **Weaver**: Where did you put your anemometer?

Mr. **Norrington**: At the top of the shafts, and I made a special arrangement to protect the anemometer so that the wind had no effect upon it, and that there should not be the slightest doubt about the figures. I could not help feeling that the whole of the money spent on the construction of these shafts—some of them cost as much as 20*l.*—had been utterly wasted. It is a common practice among surveyors, where they receive complaints of surface ventilators, to erect shafts, and in my opinion their erection is nothing more or less than a sort of subterfuge. You check the ventilation of your sewers—but you appease the clamour of the people who complain. I do not think it is worthy of us as engineers. We are, however, all sinners alike, it is only a question of degree; and the County Council are perhaps as bad as anyone in this respect. The method adopted by the Hampstead Board of increasing the number of surface ventilators is undoubtedly the proper one, and, although recommended in 1886, it has never been fairly tried by the London County Council, for none of their sewers have ventilators 60 yards apart, the distance being usually 200 or 300 yards, consequently you have 300 yards of sewer full of more or less offensive gas, and directly there is a little pressure in the sewer a very strong smell arises, and complaints are the result. I do press this meeting to consider whether we ought not to revert to the original recommendations and practice of engineers. I do not say that all shafts are useless, but I do say that the ordinary shaft which is not assisted in any way is useless. We know that shafts have been erected with gas-jets burning inside, and no doubt the gas burning will create a current of air—but at Hereford two of these even gave very little result. They cost each of them about *7l.* 13*s.* per annum, and the result was 12 cubic feet per hour. What is the use of that as a result? Even Mr. Weaver admitted he did not consider these shafts of any very great value, and that they simply had the effect of causing the complaints to cease. I still hold the opinion which I set forth on December 28th, 1894, that it is advisable for engineers to collect and publish more data for the purposes of comparison as to the efficiency of shafts before closing the surface ventilators. It is the ill-ventilated sewers which cause complaints to be made of the surface ventilators, and I strongly advocate that it is desirable to add to rather than diminish the number of surface ventilators until some better means of ventilation can be obtained.

Mr. Read: I should like to ask Mr. Norrington if the 12 ventilating shafts he mentions were in the neighbourhood of the 26 surface ventilators.

Mr. Norrington: Yes, sir; in the same neighbourhood and some on the same sewer.

Mr. Read: That being so, I do not think he could expect any other result, because the outlets must be in excess of the inlets if there is to be any ventilation at all, and they must be arranged and proportioned to agree with the action of the sewer. We are all agreed that ventilation is a necessity which cannot be avoided, because if you do not provide the means of ventilation a sewer will ventilate itself. The whole difficulty appears to me to have been created by the dictum of the Model Bye-laws of the Local Government Board, issued in 1877, which say that drains must be independently ventilated from the sewers, which means that the sewers must be ventilated by the authorities and the house drains must be ventilated by the owners. In order to divide these two systems of ventilation, the Model Bye-laws provided an intercepting trap. That intercepting trap, to my mind, is the cause of all our difficulties. It paralyses the ventilation; you cannot ventilate in that way successfully. The popular idea of ventilation is that the more ventilation you give, the more stinks you let out, but that is not so. The stinks are governed by the condition of the drain or sewer. These intercepting traps put an obstruction into a 6-inch drain 8 inches deep. What is the effect of this? You lose a large amount of the fall in the drain and largely destroy its efficiency. The difference of level between the outlet and the inlet of these interceptors has been increased from nothing up to 4 inches. The better class of intercepting traps have now a difference of 4 inches between the outlet and the inlet; but they are put in regardless of the amount of fall available in the drain above them, and the result is that the water trickles in at one end of the trap and trickles out at the other, and leaves nearly all the solids behind. That is proved by the experiments of the Sanitary Institute in 1894, a very extensive report of which is given in vol. xiv. of their Transactions. They laid down a full sized 6-inch model drain 50 feet in length, with a fall of 1 in 40, with a closet pan and flush at the top, and having an intercepting trap at the bottom, and the average of 300 discharges through that drain was that 26 per cent. of the solid matter was left in the trap with a 3-gallon flush, and 37 per cent. with 2 gallons. If this is so in a model drain laid above ground, and in a laboratory experiment, what can be expected to be the result in the case of the hundreds of drains laid underground? Why, you are providing a manufactory of sewer gas in every drain that is laid with an intercepting trap. That intercepting trap is no safeguard to the house. The true safeguard to the house is the soundness of the drain—of course, if the drain is not sound the intercepting trap, instead of being a safeguard, is a danger, because it provides the gas which is to poison the household. If the drain is sound—and we have now means of testing drains by the smoke test and otherwise, so that they can be made sound—it does not matter what you pass through it. If the drain is outside the house then there is even less reason for putting in an intercepting trap. Ventilation itself does not produce the nuisance, it simply calls attention to a nuisance. The effect of these intercepting traps is that when a lot of drains are run into a sewer, and each drain is trapped, they are supplying the sewer with sewer gas, and no amount of flushing which the authorities can do in the sewer will get rid of it, because directly the flush ceases the drains will again pour in sewer gas. The initial point of flushing should be the head of the drain at the water-closet or gully: and the whole of the flushing that goes through the drain is then available for flushing the sewer afterwards. If the drains are laid as they ought to be with good falls, and if the sewers are laid with good falls—and I contend that the sewers are generally the better of the two, for they are laid by experts, and the drains perhaps by labourers—you get a good result; and in the absense of interceptors you get the sewer and the drain acting together, ventilating the whole system in the most natural and perfect manner, and reducing the sewer gas to harmless sewer air. To my mind ventilation must consist of both inlets and outlets, and you cannot have a proper system of ventilation without it. The inlets should be small and at the road level, and the outlets large and numerous above the roofs, their action would then be constant in one direction. The proposition of putting in larger road surface ventilators for sewers is a very old one. It was made by Mr. Mansergh in connection with the Gloucester sewers in 1877. Mr. Mansergh recommended the surface ventilators to be 60 yards apart and they were made so, and have been so ever since, but nevertheless we have complaints of sewer smells from time to time, the same as you all have. The remedy for defects of sewers and drains is reconstruction and flushing combined with free ventilation properly applied, but if you depend upon ventilation alone I am afraid you will not be able to remedy the evil.

Mr. P. Dodd: I should like to ask whether the ventilating shafts experimented on by Mr. Norrington were ordinary iron pipes, and how long they had been erected, because ordinary iron pipes which have been fixed for some time are liable to become choked with oxidation. I should also like to ask whether connection with the manholes was made in the form of a bell mouth, as it is generally admitted that the pipes should not be of the same diameter throughout. If, for instance, a 12-inch pipe were fixed at the manhole and gradually reduced to 6 inches, I think a much better draught would be obtained.

Mr. NORRINGTON: In all cases where a shaft was erected the nearest manhole was closed, because the shaft was erected in consequence of the complaints of the manhole. The surface ventilators I made the observations upon were on the same system as the shafts. The shafts in some cases were fairly close to the surface ventilators, and in others a good distance away. With reference to the construction of the shafts, the results I obtained were so astounding that I took the trouble to re-open them to determine if there was any stoppage, and I can assure Mr. Dodd that I found no obstruction whatever in any of them. Whether the shaft was a 6-inch or a 4-inch one, I put a 9-inch pipe from the nearest manhole to the bottom of it.

Mr. DODD: I think all iron ventilating pipes should be galvanised or glazed inside, otherwise, as I have stated before, they become completely blocked at the bottom of the pipe with iron rust in about two years' time. I quite agree with Mr. Weaver, where intercepting traps are insisted upon, in having a ventilating pipe for each house on the sewer side of the trap. If not, miles of drains between the sewers and the trap would remain unventilated. Also the street surface gratings ought not to be sealed, because it is desirable to get as many openings to the sewers as possible, in order to promote as much as possible the circulation of air through the sewers and the ventilating pipes.

Mr. W. N. BLAIR: I want to give some more figures rather in contradiction to what Mr. Norrington has said. They are also facts: some of them taken some years ago. These figures were taken at Bootle in 1892. We had there an outfall sewer, with manholes and ordinary surface covers about 100 yards apart. This sewer received the effluent from the gas-works, it was very foul indeed, and was tide-locked twice in the twenty-four hours. Therefore the whole volume of air displaced by the tides was forced up the sewer out of the manholes on to the carriageways. We had so many complaints that the Corporation felt they must do something to try to relieve the difficulty. We therefore put up one of Holman's sewer ventilating columns, and after that had been working some time I found that it was passing 2430 cubic feet per hour, the velocity in the shaft being

235 feet per minute. On another occasion I tested the same column, and the test showed that it was passing 2640 cubic feet per hour with a velocity of 260 feet per minute. This was done at a cost of 10*l.* or 12*l.* per annum for gas. We then put up some plain 6-inch pipes—heavy rain-water pipes—tarred inside and out, and in one we got a result of 2626 cubic feet per hour on one occasion, and on another occasion 1492 cubic feet. With another plain 6-inch shaft we got 2520 cubic feet per hour, and with a third one 2356 cubic feet per hour; so, if you take them on the average, we got quite as much result from a 6-inch plain pipe of 35 feet height, as we got from a Holman column, which cost us 12*l.* a year for gas. Let me give you another set of figures taken in London. The northern end of my district rises to 430 feet above Ordnance datum, the greater part of the rise, about 230 feet, occurring in a distance of about half a mile. The gradient of the road is about 1 in 10 or 11, and the sewer, which is 3 feet 6 inches by 2 feet 6 inches, follows the same gradient, and, being connected with the main drainage system of London, you might naturally expect to find a considerable amount of smell coming from the ventilators on that sewer. That has been the case, and it has been flapped off. First of all I cut that sewer into three lengths, with a sheet of india-rubber about ½ inch thick, with light battens fixed on the rubber to prevent it buckling up. A short distance below each of these flaps I got in a pipe connection up to a building near the road, and erected a plain shaft in two cases, and in a third case connected on to an existing Holman's ventilator. With regard to that, I got very different results from the former test. In November 1893, during 15 minutes—it was, by the way, connected with a 12-inch pipe with bell mouth—there was absolutely no movement in the anemometer. Then I proceeded to take out the furnace, the plates and things, but leaving on the top gear, the cap and the lamp, and on the next test I got a result of 10,096 cubic feet per hour.

Mr. Weaver: Was the lamp alight on the top?

Mr. Blair: There was no heat at all in that case. With the same conditions existing at the bottom, and the cap and lamp off the top, all clear, with no heat, we got 16,290 cubic feet per hour, and with similar conditions, but with gas-jet lighted at the bottom, 19,320 cubic feet per hour. That is a difference of one-sixth with the use of gas costing 12*l.* a year. After all that I reinstated the column in its normal condition, with everything in at the bottom, the cap and the lamp on at the top, the gas-jet alight, and tried the result with the anemometer—it was nil. With regard to the two plain pipe columns I have not any figures, but I can say, speaking from observation in the sewer—where you can easily see whether you have a good current or not—that I have often found a very good current coming out of those pipes, and although they are at the summit of a section of sewers with a gradient of about 1 in 11, I have on some occasions found the current going down the ventilating pipe and coming out of the surface ventilators. But even in that last condition there is certainly no nuisance in that road, where formerly there was a terrific nuisance. I do not think it matters which way the air moves, if you can only get it to move freely. I am very much in agreement with Mr. Weaver, but I think there is very little prospect of getting compulsory power to require owners of property, without any consideration for the architectural aspect of their houses, or the effect which might be produced upon their letting value, to put a ventilating pipe up in front. In nine cases out of ten they would have to put the pipe up the front of the house to ventilate on the sewer side of the interceptor. That is what we want, but we shall not get it. The introduction of the syphon trap has undoubtedly interfered with the ventilation of the main sewers. But we must remember for what purpose and under what conditions the syphon was introduced. It was introduced with the object of shutting off the gas in the main sewers from the house drain, because at that time house drains were not to be relied upon as to being either gas or water-tight. Now we can rest assured that drains constructed under the modern requirements of almost any corporation's bye-laws are both air and water-tight, there can be no harm in allowing the air from the sewer to pass through the ventilation pipe provided for the ventilation primarily of the drain. At the same time, I think there are many of us who would hesitate to have a drain passing under our houses to ventilate a public sewer. Where the drain is in a garden no one need hesitate. There is one other consideration which should come in at this point, that is, that no connections with any drain so constructed as to ventilate a sewer should be allowed within the house. Many of us here know how slight is the seal of some gullies, and how the discharge of a closet will cause pulsation in the trap of any gully. Sometimes you will see the water oscillate up and down perhaps an inch in extent. Such action might unseal the gully, and if the gully were within the house, that would admit the air of the sewer into the house. Therefore, where gullies are necessary inside a building, I say most emphatically that the drain into which those gullies discharge ought not to be used as a ventilator for the sewer. But there are many cases in which drains might without any harm be so used if the owners could be persuaded to allow it. But there is something in the point Mr. Weaver mentioned, although he put it down to statute; it is a bye-law which requires every person to ventilate the whole of the drains of his premises, but by trapping off by a syphon you may have a length of drain, perhaps 40 feet, which is not ventilated. I think the owner should be required by the bye-law to ventilate that portion as well as that which is above the syphon, and therefore to that extent we are justified in asking the owner to provide an additional ventilating pipe for the portion of the drain below the syphon. That would ventilate the sewer, and at the same time it would leave the house drain free from any risk which there might be if sewer air were passing through it. As to the first suggestion Mr. Weaver makes in his report—that "it shall be compulsory on the owner of the premises to carry up a ventilating pipe not less than 24 square inches in sectional area from the sewer side of the interceptor up the front, side, or back of the house, to the satisfaction of the local sanitary authority"—there comes in the difficulty as to the position. The defacement of the property would no doubt influence many people in resisting any such order. With regard to the complaints of manholes on the surface of the streets, while I am a strong believer in them, at the same time I quite sympathise with Mr. Weaver's views of them in such a district as Kensington, where there are so many macadam roads. No doubt a great amount of grit and sediment does get into the sewers through these manholes, and causes a deposit of the very material in the sewage which afterwards begins to ferment and give off the smells which cause so much trouble. The suggestion to put buckets in the sewers at these places only leads to further trouble; those who are supposed to empty the buckets do not always do it, then they spring their hangers, and fall to the bottom and cause a bigger block in the sewers than ever. Where you have liability to get macadam and grit into the manholes, as, for instance, after covering the road with new macadam, it would be desirable to keep the buckets in, but I would not keep them there permanently.

Mr. **Weaver**: I think the only way to test the feeling of the meeting, so as to enable me to put my resolution next Friday at the Conference at the London County Council, is to put my resolution to the vote. I shall not move that resolution next Friday unless I feel it commends itself to my brother surveyors. I therefore move, that it is desirable that, in connection with any interceptor hereafter fixed on a main house drain, it shall be compulsory on the owner of the premises to carry up a ventilating pipe not less than 24 square inches in sectional area from the sewer side of the interceptor up the front, side, or back of the house, to the satisfaction of the local sanitary authority.

Mr. **Blair** formally seconded the proposition.

Mr. **Norrington**: I think Mr. Weaver deals rather with the fringe than the main lines of the subject. I will propose that the Council be recommended to carry out the recommendation of the Metropolitan Board, as contained in section 10, page 10, of Mr. Weaver's report, viz. "That surface ventilators be placed every 50 or 60 yards apart in existing sewers." That has never been tried by the Council, and until it is done, I do not consider that the principle of surface ventilation has been given a fair trial. I would start with that: though any further addition to the ventilation of the sewers will be in the right direction.

Mr. A. **Southam**: I shall have pleasure in seconding that.

Mr. **Weaver**: You say that the remedy for complaints of smells from sewers should be sought in the direction of the multiplication of open grids in the road surfaces.

Mr. **Norrington**: I say that is one remedy, perhaps the best remedy.

Mr. **Weaver**: That must be taken as an amendment. If you go in for pipe ventilation you must reduce the number of the street surface ventilators.

Mr. **Norrington**: I decline to put it as an amendment. I say the first thing to do is to ventilate the sewers. The Metropolitan Board have recommended surface ventilators, and it is our duty to ask their successors to carry out that recommendation.

The **Chairman**: It appears to me that you are trying to ventilate the sewer through private property. I do not think many of the local authorities would advocate this arrangement. The proper course is for the drain to be in such proper working order as to clear itself at all times, and then for the local authority to be responsible for the sewer and its ventilation at the point where it connects with the drain. I do not think the local authority could rightly call upon private owners to ventilate the public sewer; this plan would need additional legislation.

Mr. W. A. Davies: I take it that between the sewer and the trap there is a certain length of drain unventilated, and the pipe is suggested to ventilate that portion of the drain.

Mr. Weaver: I touched upon it as part of one system. It is absurd for the householder to create a smell and give it to the surveyor to get rid of in the public sewers. I say, help to get rid of the common evil you help to generate. I think it is the simplest plan of getting rid of the evil.

Mr. Dodd: I should like to recommend that both resolutions should be put together to the meeting.

The Chairman: I do not see why you should not carry both resolutions.

The propositions of Mr. Weaver and Mr. Norrington were then put to the meeting and carried unanimously.

Mr. Weaver: I have a further resolution to propose, "That the local sanitary authority shall be empowered by statute to carry up any building sewer-ventilating pipes." If the sense of the meeting is that that power might be exercised prejudicially in certain cases, that might be corrected by giving the owner of the property the right of appeal to the London County Council, but I may point out that the interest of the local authority is not to disfigure good buildings, and depreciate their rental value, but to improve the same.

Mr. Blair: I cannot second Mr. Weaver's proposition, because I consider it has already been dealt with.

The Chairman: Had we not better rest as we are, and not attempt to force the hands of the County Council further?

Mr. Weaver: I am prepared to withdraw this resolution.

The resolution was then, by leave, withdrawn.

Collection of House Refuse from Flats.

Mr. G. R. W. Wheeler: The increase in the class of property commonly known as "flats" adds to the work of a municipal authority by reason of the larger number of persons housed per acre compared with the ordinary dwelling house, and also the use of gas, &c., for cooking purposes.

Owners of flats are constantly requisitioning for some concession or other, and it is to be observed that all these requests are with the object of decreasing their expenditure. Prominent among the demands are—

Refuse to be removed during certain hours every day, 7 to 8 A.M. being the hours asked in Westminster.

Refuse to be removed from *each* floor of a "flat."

I am constantly asked to remove refuse before 8 A.M., but am in the unfortunate position of working in a district where the police prohibit the loading or unloading of vans in many of the streets after 10 A.M. This regulation has led to the work in these particular streets engaging the attention of practically all the available plant each morning before that hour, and a non-compliance with the special requests from other streets has resulted in the men being sent away when they have called later in the day. Of course the ratepayer has eventually to submit; and, it may be added, the inconvenience is not confined to the individual, as other work is being delayed.

In respect to the demands for removal from various floors of buildings, the experience in Westminster shows that the matter is not at present a serious one. Dust is removed from the fifth floor of one building, the fourth floor of three buildings, the second floor of two buildings, and the first floor of five buildings in the parish. In all other premises the dust is removed from the basement or ground floors. The law compels vestries to remove refuse from all premises within their parishes, and it may be taken as reasonable that the refuse should be placed in a convenient position. The old custom was to remove refuse from the lowest floor, and, as many buildings have basements, objection ought not to be made to the dust being as far as the first floor. In other cases I think that if inconvenience occurs, simultaneous action should be taken by surveyors, so as to secure uniformity of system in London.

I have a strong objection to shoots and fixed bins, and would welcome any measure which would lead to their abolition. In the case of "flat" property I would advocate the provision of a duplicate set of small bins. One set of bins should be taken from each flat daily and placed in a position convenient of access, and the duplicate set used. The law should be amended to make it an offence to refuse the dustmen admission. Water and gas companies have power of admission, and it is an anomaly that greater respect is paid to property than to health.

The **Chairman**: We compel the householders to keep the skips or bins in the basement or on the ground floor. My men are not allowed in any case to go upstairs to fetch the dust away. We have found that the occupiers of flats in some cases claim each flat as a separate house, and maintain that this Board ought to make a collection for each flat. In Hampstead if it is required to visit more than once in the week, we charge extra for each "flat" visited.

Mr. **Norrington**: What power have you to charge?

The **Chairman**: The only power we have is that we decline to clear away oftener than once a week unless a payment is made. You may doubtless remember that the County Council tried to make it compulsory to have a daily collection, but did not succeed.

Mr. W. N. **Blair**: I quite agree that a common receptacle or bin easily accessible on the ground level is the right thing, but we should be careful to avoid dust shoots. I have known of a few instances where they have proved to be a very serious nuisance.

Mr. **Dodd** formally proposed a vote of thanks to Mr. Lowe for presiding, which was seconded by Mr. C. G. **Lawson**, Southgate, and adopted with acclamation.

DISTRICT MEETING AT WIMBLEDON.

April 30, 1898.

Held in the Council Chamber of the District Council,
Broadway, Wimbledon.

JOSEPH LOBLEY, M. INST. C.E., PAST-PRESIDENT, *in the Chair.*

THE Chairman of the Wimbledon District Council (Mr. Donaldson) received the Members, and offered them a hearty welcome to Wimbledon.

Mr. Lobley apologised for the unavoidable absence of Sir Alexander Binnie, and thanked Mr. Donaldson for the welcome accorded to the Association.

The Minutes of the last Meeting having been read, Mr. Laffan was unanimously re-elected Honorary Secretary for the Home Counties District.

The following papers were read :—

MUNICIPAL WORK AT WIMBLEDON.

BY C. H. COOPER, ASSOC. M. INST. C.E.

INTRODUCTION.

THE Association has on one occasion, in September 1889, visited this district, when the Author's predecessor, Mr. William Santo Crimp, M. Inst. C.E., gave a full description of the district, the sewers and sewage treatment. Unfortunately, Members who have joined subsequent to 1889 have not this most interesting paper before them; the Author may therefore be allowed to recapitulate much of the information it contains.

DISTRICT.

Wimbledon lies south-west of Charing Cross, the centre of the district being seven miles distant; it contains 3220 acres, and extends about three miles from west to east and two miles from north to south. The district is divided into two plateaux; the west-central portion, somewhat in the shape of a horse-shoe with the toe pointing south, is raised about 120 feet above the lower plateau, or 180 above Ordnance datum. The gentle slopes joining these plains afford attractive sites for villas, whilst on the higher ground, which contains a large expanse of common, many large houses are situated, some of which are of historic interest. On the west the district is bounded by the Beverley Brook, and on the east by the River Wandle; these streams provide the natural outfalls for drainage.

Wimbledon Common contains 1140 acres, of which 640 are within the district, and almost joins Richmond Park and Coombe Woods, thus providing a large expanse of woodland scenery.

The south and south-west portions of the district contain the largest proportion of the population, and to provide open space for their recreation three grounds of about eight acres each have been laid out by the urban authority.

GEOLOGY.

Wimbledon is situated well within the London basin, and until the Southwark and Vauxhall Water Company commenced pumping from their well at Streatham, in 1889, the lower parts of the district were principally supplied with water from Artesian wells sunk either to the Thanet sands or chalk. At Paxton Leather Works a small mill was worked by the flow from one of these wells. In the higher portions of the district, gravel overlying the London clay comes to the surface; the remainder of the district is clay, with patches of sand and gravel.

WATER SUPPLY.

The water supply for that portion of the district which is 100 feet above Ordnance datum is obtained from the Southwark and Vauxhall Water Company, that for the remainder of the district is from the Lambeth Water-works.

LIGHTING.

The gas supply is in the hands of the Mitcham and Wimbledon Gas Company. As the company refused to lay mains in certain new streets in 1880, the late Local Board lighted these streets with oil; the experiment proved so successful, that the Board—sooner than accede to the large demand of 5*l.* 10*s.* per lamp per annum from sunset to sunrise—extended the system to all street lamps, which were maintained at 2*l.* 11*s.* 9*d.* per lamp per annum. For many years the lighting has been done by the authority's own men. In order to prevent fire spreading should the oil be ignited, it is stored in cast-iron tanks placed beneath the surface.

There are now 910 lamps for street lighting, the following being the average cost per lamp for the year ending March 31, 1898:—

	£	*s.*	*d.*
Wages	1	7	9
Oil, 63 gallons at 4⅝*d.*	1	4	3
Glasses and wicks	0	1	6
Other materials	0	2	4
	2	15	10

As the system has its disadvantages, it is hoped that before long these lamps will be supplied with electric light.

RAILWAY ACCOMMODATION.

Wimbledon Station is on the main line of the London and South-Western Railway. The Metropolitan, the District, and the London, Brighton and South Coast Railways also run into the station.

VITAL STATISTICS.

Wimbledon appears to have been exceptionally free from epidemics. The outbreaks of cholera, which during this century proved so fatal in the Metropolis, did not invade this district. The annual zymotic death rate since 1880 has not exceeded 2·3 per 1000, the average being 1·54. The total death rate during the same period did not exceed 14·9, the average for the eighteen years being 12·37.

Population.

In 1861 the population of Wimbledon was 4644, to-day it is 38,000, having increased 2000 in the last twelve months.

Finances.

The indebtedness of the district is 138,000*l.*, the rateable value 230,000*l.* For some years back the general district rate has kept at 3*s.* 2*d.* in the £ per annum.

Drainage.

With few exceptions the roads contain separate sewers for sewage and rainfall, the latter being conveyed by a system of outfall sewers to the natural watercourses. These sewers take the drainage from the road gullies and the rainfall from the fronts of the houses. It has not been thought desirable to duplicate drains at the rear of houses.

The following is a list of the intercepting sewers which take sewage to the sewage farm and works. Branch sewers are not included.

Name of Sewer.	Length in Yards, not including branch sewers.	Size.	Population drained.	Daily Dry Weather Flow in Gallons.	Remarks.
High level ..	4,900	2′ 3″ × 1′ 6″ to 12″	4,200	252,000	
Middle level ..	6,053	3′ × 2′ to 12′	6,000	180,000	
Low level ..	6,060	3′ 9″ × 2′ 6″ to 15″	26,000	700,000	
Summers Town	1,160	9″	230	5,200	
Totals ..	18,173	..	36,430	1,137,200	

Pumping Stations.

The high-level and middle-level sewers gravitate to the sewage works. The low-level and Summers Town sewage has to be raised at the works. The low-level sewage is raised an average of 22 feet by two pumps having two 2-feet diameter plungers, single action, with 4 feet 6 inches stroke, raising 166 gallons each stroke. Each pump is actuated by a 16-horse-power horizontal engine, with 14-inch diameter steam cylinder, 3-feet stroke, double-acting condensing, the power being transmitted by cog gearing to the pumps. The steam for the engines is produced in one of two Lancashire boilers, 20 feet in length and 6 feet diameter, the pressure of steam generated being between 45 to 50 lb. per square inch.

LOW-LEVEL SEWER.

The low-level sewer as constructed was so defective that the late Board, under Mr. Crimp's advice, reconstructed the greater portion of it, and, in order to provide self-cleansing sewers in Cottenham Park and to take the sewage of Warren Farm, the Raynes Park pumping station was erected. The sewage is raised at this station 33 feet. There are two pumps, each having one 12-inch diameter plunger with a 24-inch stroke, worked by one of two 3½-horse-power Otto gas engines. By means of a loose shaft either pump can be coupled up with either engine. The power is transmitted by cog gearing, the wheel having wood cogs.

The Author carried out, in accordance with plans prepared by Mr. Crimp, the enlargement of the low-level sewer in Pelham Road for a length of 2050 feet. The crown of this sewer was taken off, excavations were made on either side 12 inches wide and 15 inches deep, and the outside of the brickwork was scrubbed clean; Portland cement concrete was then filled in level with the top of the brickwork, which formed foundations for concrete side blocks; a 4½-brick arch was carried on these side blocks. By this means the size of the sewer was increased from 1 foot 6 inches by 2 feet 3 inches, to 2 feet by 3 feet 6 inches, and its carrying capacity from 200 cubic feet per minute to 510, at a cost of 2*l.* 4*s.* 6*d.* per yard, including 2*s.* per yard for timbering.

The work was carried out without interfering with the flow of sewage, and only on two occasions of flooding did the sewage interfere with the work.

The Summers Town sewage is raised by two 50-gallon Shone's ejectors. These, together with similar ejectors near the northern end of Durnsford Road, can be divided by the exhaust air from the sludge rams.

ALTERATIONS TO PUMP WELL.

The pump well at the sewage works, as constructed, was half under the engine-room floor; the bottom had no fall and the suctions were both inside, so that the greater part of the well became blocked with settlement which there was no means of removing. The Author in 1894 removed part of the floor in the outer well and formed sumps to receive the suctions, which were lengthened so as to reach the sumps; the gratings previously fixed round the suctions were dispensed with, and the portion of the well under the engine room filled in to above the water line and concreted.

This improvement allows the well to be pumped dry, and prevents sewer gas from the pump well escaping into the engine room, and further reduces the coal consumption by about 3 cwt. a day.

SEWAGE TREATMENT.

Sewage Farm.—The following table gives the areas devoted to the various parts of the farm:—

	Acres.
Tank and buildings	2·62
Roads and land not devoted to sewage	4·50
Storm water filters	2·10
Cultivation filters	2·00
Irrigation ground for first run	32·75
Ditto, second run	24·50
Now occupied by temporary hospital	4·75
Total	73·22

The area under the various crops may be given thus:—

	Acres.
Rye grass	34·12
Osiers	15·
Mangel-wurzels Market gardening	10·24
Total under crops	59·36

The following table gives the annual receipts and expenditure in connection with the farm since 1883 :—

	Receipts.			*Expenditure.*		
	£	*s.*	*d.*	£	*s.*	*d.*
1883	661	10	0*	834	7	2
1884	816	16	6*	690	8	5
1885	782	8	1*	702	3	4
1886	936	12	10*	793	10	0
1887	1,019	9	2*	993	5	9
1888	1,414	15	10†	897	2	1
1889	1,186	7	2†	811	4	3
1890	1,202	1	1†	833	0	1
1891	1,026	9	1†	830	6	0
1892	971	15	10†	1,134	5	0
1893	1,287	12	2†	1,011	3	4
1894	1,923	13	10†	1,244	4	9
1895	1,067	12	9†	926	12	11
1896	1,403	1	0†	919	8	8
1897	1,098	1	6†	812	18	3

* Not including produce consumed by the council's horses, amounting annually to about 300*l.* in value. † Including value of produce consumed by the council's horses.

High-level Tank and Filters.—The sewage brought by the high-level sewer enters the bottom of the receiving chamber of the two high-level tanks. The sewage that flows into the tanks is drawn from the top of the chamber by one of two pipes, down which it flows and so enters one of two tanks above the invert; each of these tanks has a floor of 2-inch by 2-inch battens placed 1 inch apart, carried on joists. On this floor there is about 5 inches of broken brick about 2½-inch gauge, which forms a screen through which all sewage that enters the tank must flow in an upward direction. If greater depth or smaller material is used the sewage comes up only in certain places, so that the flow is not evenly distributed over the tank. This system arrests all the grosser matter and almost all the suspended matter found in sewage, without the addition of chemicals. The tanks and filters are cleansed once a week, the sludge, &c., gravitating to the settling tanks at the sewage works. The effluent from these tanks is run twice over land before passing into the river. These tanks are each 30 feet by 20 feet, with an average depth of 7 feet. As constructed it was impossible to allow these filters to aerate, nor was any provision made for emptying the syphon which conveyed the sewage to the tanks. In 1894 the Author altered the tanks so as to allow one tank to remain empty whilst the other was working, and at the same time lowered the syphon outlet as much as possible.

The remainder of the sewage flows direct to the sewage works, where sufficient proto-sulphate of iron is added to the low-level sewage before it is pumped to allow 4 grains per gallon for all the sewage to be treated; 12 grains of lime per gallon is afterwards added to the sewage in bulk. The sewage thus treated passes along a conduit into one of six settling tanks, which communicate by weirs and are each fitted with a floating arm and sludge outlet so that they can be used separately or in series. Each tank is 50 feet by 49 feet, by 7 feet 6 inches deep, and contains about 92,000 gallons of sewage, or 552,000 in all. Every weekday one of these tanks is cleaned out, the sludge being run into the sludge reservoir.

The tank effluent, as a rule, passes off over a weir at the end of the last tank, and into a series of cast-iron distributing mains laid about 3 feet beneath the surface, or it can be drawn off by the floating arms which communicate with the same mains. From these mains the tank effluent can be run either on to irrigation ground or cultivation filters. The effluent from the ground or filters is again run over land before passing into the river.

Filters.—As there is no possibility of acquiring land to cope with the increase in sewage due to the increase of population, the nitrifying capacity of the land has to be increased by converting it into filters.

The first filter was constructed in 1876, of burnt ballast 3 feet deep, and is still in use both for storm water and at times as a cultivation filter.

The Author, in 1893, completed an extension of 2900 yards super. to the storm-water filter, and a cultivation filter of 5300 yards super. Both filters were constructed of the material excavated on the site, the clay having been burnt to form the ballast.

The ballast was passed through sieves, the large material being used to form the filtering material, which in both filters was 3 feet deep; in the storm filter this material was left uncovered, whilst the cultivation filter was covered with a layer of 9 inches of fine burnt ballast and a layer of soil 7 inches thick. In the storm-water filter the subsoil drains were placed 6 feet apart, whereas in the cultivation filter the drains were 10 feet apart.

As first constructed, the subsoil drains from the cultivation filter discharged over an open channel, but, as it was thought desirable to try the filter as a tank, this channel was abandoned, and the drains connected with one main drain discharging into a valve chamber. The filter, however, did not give such good results as it did with the drain outlets open for the passage of air. The Author has lately provided ventilation by carrying up the drains at the highest points.

A second cultivation filter, similar to that just described, was completed this year, and ballast is now being burnt for two acres of cultivation filters, which will be placed at such a level as to take the effluent from the existing cultivation filters.

It is proposed to construct a carrier, 2 feet 6 inches by 2 feet, to take the effluent from the existing filters on to the proposed filters on lower ground.

A tramway, of 2 feet 6 inches gauge, is to be carried on piers over this carrier, to take road débris and other refuse on to the lower land which requires raising. The inclination (1 in 202) is sufficient to gravitate the truck, which will be brought back by an electric locomotive worked from an overhead wire.

The Author would point out that with the exception of six acres near Earlsfield, the farm is on stiff clay. When the present farm manager, Mr. J. Snook, took charge in 1879, the effluent from this farm came off quite as polluted as the raw sewage, which was due to no attempt having been made to prevent the sewage soaking direct to the drains. Mr. Snook soon obviated this, amongst other defects, and showed that sewage can be cleansed on clay ground. House refuse and sludge cake have with the best results been dug or trenched in from time to time, so that there is now twelve inches in depth of fair soil where formerly none existed.

Sludge.—The sludge, as before mentioned, passes from the settling tanks into the sludge reservoir, which has a capacity of 6700 cubic feet; the top water is drawn off by a weir. The sludge from the reservoir passes through a 6-inch pipe to the rams in the press house. There are three of these rams, two having a capacity of 40 cubic feet, and one, added by the Author, of 380 cubic feet; the latter is capable of charging all four presses. Whilst the sludge is passing through the 6-inch pipe just mentioned, hot ground grey chalk lime is added in the proportion of 1·1 per cent. to the tank sludge.

Air at a pressure of 80 lbs. is supplied to the rams by a

Goddard, Massey and Warner's double-acting tandem air compressor, having a 12½-inch diameter steam cylinder, and 8-inch air, with 16-inch stroke. A Johnson double-tandem compressor with 10-inch steam cylinder, 9-inch air, with 20-inch stroke, is about to be fixed; both the compressors to be placed in the engine-room at the pumping station.

The waste air from a ram when empty can be used to do the mixing and first part of the pressing in the other rams, and is also used to work the ejectors to further facilitate the utilisation of waste air; two air receivers are about to be erected.

There are four sludge presses: two of Johnson's, erected in 1884, having twenty-four 3-feet diameter plates each; one of Manlove's, erected in 1888, which has twenty-two plates 3 feet square; and a similar press of Goddard, Massey and Warner's, with Warner's buckle plates, erected in 1893.

About 100 tons of sludge cake is produced weekly. As there is now no demand for such product, it is proposed to erect destructors in connection with the electric light station, to consume both cake and house refuse.

COST OF PRESSING PER TON OF CAKE.

	d.
Lime	7·15
Cloth	2·35
New plates	·68
Sundries	·12
Coal	3·53
Oil and waste	·59
Wages	9·84
	2*s.* 0¼*d.*

SURFACE-WATER SEWERS.

A considerable portion of the main surface-water sewers were constructed by Mr. Crimp, who, when surveyor, laid down lines for extensions and for additional outfalls.

The Author, in carrying out this work, has used circular concrete sewers with inverts of special bricks in blue Staffordshire clay, which he designed. These inverts form a modified egg shape, so that with a small flow the water is concentrated and not allowed to spread, as it otherwise would, over a segmental invert; the hydraulic mean depth is thus increased.

In 1894 a 3-feet diameter surface-water sewer was constructed in concrete 6 inches thick, with blue brick invert as described, for 7*s.* 5*d.* per foot run; as difficulty was experienced in removing the centres after the arch had set, the Author, in sewers subsequently constructed, has adopted for the arch a single ring of brickwork backed with concrete.

In 1895 the western surface-water outfall alongside Kingston Road was extended in 3-feet 6-inch and 4-feet diameters with blue brick invert and arch, as described; the thickness of the 3-feet 6-inch sewer was 7½ inches, which cost 10*s.* 6*d.* per foot run, and the thickness of the 4-feet, 9-inches, which cost 13*s.* 8*d.* per foot.

Neither of the three surface-water sewers just mentioned required much excavation, the crown being about the same level as the surface of the ground.

Flood Prevention Works.—In consequence of serious flooding in the lower portion of Wimbledon Hill Road and the roads adjoining, the Author was instructed to prepare a scheme for preventing as far as possible a recurrence of such flooding.

The scheme proposed will convey storm water direct on to the storm-water filters at the sewage farm, so that such water will get a partial cleaning before passing into the stream.

The scheme embraces the construction of 4166 feet of 3-feet diameter sewer, with a fall of 1 in 143, from the storm-water filters through the farm, under the London and South-Western and District Railways, along Stratharn and Alexandra Roads to Park Road.

This sewer will be constructed in 9-inch brickwork with blue Staffordshire invert.

The sewer will be continued along Alexandra Road, from Park Road to its junction with Wimbledon Hill, in 2-feet 3-inch diameter sewer with a fall of 1 in 533; a branch sewer will be laid from the 3-feet sewer opposite Park Road, along Park Road and Woodside to Wimbledon Hill, in 2-feet 3-inch and 1-foot 9-inch diameters, to intercept water coming from the Park, Belvedere, and Wimbledon Hill; whilst the Alexandra Road sewer will relieve flooding in the lower part of Hill Road.

The 2-feet 3-inch and 1-foot 9-inch sewers will be constructed with concrete tubes surrounded with concrete carried down to form a flat base.

STREET IMPROVEMENT WORKS.

Wimbledon Hill.—In the autumn of 1891 the Author prepared a scheme for widening Wimbledon Hill for a distance of 1500 feet. At that time no part of the Hill was more than 40 feet in width, and at one place it was only 27 feet wide. Inside the wall that divided the Hill from the property on the north were the forest and flowering trees seen to-day. One great object of the scheme was to preserve these trees.

The Chairman of the late Local Board, Mr. J. Townsend, J.P. secured 1¼ acres for 2500*l.*, in order to carry out the scheme and widen High Street, which was then only 27 feet to 50 feet in width.

The work was commenced early in 1892, and completed in July of that year by the Board's staff, at a cost of 3000*l.*, without the assistance of a contractor.

The work as finished has on the south side a path 10 feet wide, the Hill portion is paved with Stuart's Granolithic *in situ*, while in High Street Stuart's slabs were used. The carriageway is channelled, and in the Hill has a width of 33 feet, with borders 17 feet in width placed between the carriageway and the path on the north side. These borders allowed the trees before mentioned to be retained; a few shrubs have been planted, which, with ivy-covered stumps, give a pleasant appearance. The borders on the higher part of the Hill are some 3 or 4 feet above the carriageway, which necessitated a dwarf retaining-wall constructed of brick.

Wandle Bank Improvement.—In carrying out this work a retaining wall was constructed alongside the river Wandle for a length of 1200 feet. The wall is constructed of Portland cement concrete, 1 of cement to 6 parts Thames ballast, and varies in thickness from 1 foot 2 inches at top to 3 feet at the base, including 12 inches of toe; there are counterforts, 14 inches by 12 inches, 12 feet apart, carried to within 12 inches of the top on the road side. The wall varies from 5 feet 6 inches to 7 feet 6 inches in height, the height out of ground being from 4 to 5 feet; it is coped with blue brick, and carries a 4-feet unclimbable fence.

The ground on which this wall is built varies from gravel almost as solid as concrete to the worst form of running silt. Cracks were expected, but as yet none have appeared.

This work cost 14*s.* 2*d.* per foot run.

Depôt.

The want of sufficient depôt accommodation entailed considerable expense and inconvenience, especially in the case where the material for road repairs came by rail.

The Author, in 1894, advised the Council to purchase three acres in Queen's Road alongside a joint line of the London and South-Western Railway and the London, Brighton and South Coast Railway. The vendor insisted on most formidable restrictions, and although the Author looks on such restrictions merely as objects for skilful handling, others considered they would detract from the utility of the site. However, after much trouble, the site was purchased in 1895 at 2250*l.*, or 750*l.* per acre. This year the land opposite sold at the rate of 1437*l.* per acre.

So soon as the site was acquired, a siding was laid in from the railway in such a position as to allow materials to be stored on either side. The Author suggested to the vendor to store material in the front portion of the site, which the stipulations did not prevent. The vendor, however, considered it would be preferable to allow a row of buildings to be erected so as to exclude the store yard as much as possible; he therefore waived the stipulation preventing stabling on condition of his house next the yard being purchased at a very reasonable price. So much for formidable stipulations, which, except that the elevation to Queen's Road is more ornate than it might otherwise have been, had no detrimental effect.

In designing these buildings, the Author took the width of 30 feet, which he found was usually adopted in the case of stables for two rows of horses, and decided on a width of 7 feet, i.e. 6 feet 6 inches in the clear, for the stalls. It was settled that not more than thirteen horses should be housed together. The stables, and the buildings intended to be converted hereinafter into stabling, are divided by party walls into sections, having a clear length of 49 feet 6 inches; for convenience and superintendence an iron door has been placed in the party walls.

Facing Queen's Road, for a length of 505 feet, and having a south by east aspect, is a continuous row of buildings with red brick fronts, terra-cotta dressings, and green Eureka slate roofs. The central portion contains the archway which forms the principal entrance to the depôt, with the residences for a store-keeper and horse-keeper. This portion has two stories, with a third in the central roof, and forms a well-marked central block.

On either side of this block are buildings with a ground floor only. The roof running parallel to the road has the central portion carried up to form a lantern light 6 feet wide, with lights 2 feet deep on either side made to open.

On the west of the central block comes the harness room, 20 feet by 18 feet, with a repairing shop, 19 feet by 11 feet 6 inches, in front; three stables for 39 horses; and a cart shed 42 feet long. On the east side comes the foremen's mess-room, 12 feet 10 inches by 18 feet 3 inches, with testing-room, 11 feet 9 inches by 11 feet, in front, and the workmen's mess-room, 11 feet 9 inches by 30 feet, with a loft over both mess-rooms; four cart sheds, having a total length of 173 feet; two road roller houses, 11 feet 9 inches by 30 feet, with benches at one end; the coal and coke stores are placed next these houses.

At a distance of 30 feet from the front block, and on the east side of the entrance, is a back block, containing in the end nearest the entrance a time-keeper's office, to be used also as a pay office, 7 feet 6 inches by 11 feet 6 inches; a store-keeper's office with stores, 15 feet by 30 feet; a fodder store, 30 feet by 30 feet, with engine-room and room for food boiler. Over this portion is the corn store, 27 feet 3 inches by 30 feet, and the fodder loft, 41 feet 1 inch by 30 feet, both having a Fawcett's fireproof floor.

Next is a carpenters' workshop, 29 feet 7 inches by 30 feet, and a painters' workshop, 30 feet by 30 feet, both having doors that allow of carts being taken inside. Next to the workshops is a cart shed, 41 feet 4 inches by 30 feet, and then six loose boxes, each 14 feet 7 inches by 14 feet 8 inches, for the isolation of horses. These boxes are divided off by party walls, the roofs being carried up to form lantern lights, and have a rolled joist from which to sling horses if occasion requires.

The contract price for erecting these buildings is 9444*l.*

ISOLATION HOSPITAL.

When the sewage farm was laid out in 1876, an old mansion that was on it, Durnsford Lodge, was converted into an isolation hospital. This building was never in good order, but as years advanced it became still more dilapidated, so much so that in 1894 it was abandoned. The present hospital is a corrugated iron building, capable of accommodating thirteen beds. To provide for a greater number of patients two new tents were erected last autumn, on the sites prepared for the tents described by the Author in vol. xx. of the Proceedings. All this accommodation is situated on the sewage farm, and although neither the old building nor the present erections could be considered suitable, yet the deaths which occurred are only 4·05 per cent. of admissions, which included small-pox and diphtheria.

Since 1891 the urban authority have considered the question of erecting a suitable hospital. An inquiry was held in October 1896, to convert the upper cemetery field into a site for an isolation hospital. An injunction was applied for to restrain the Council from erecting a hospital on such site, but as this injunction has been dismissed, it is hoped that before long the proposed building may be commenced.

The site contains 4·75 acres, and is estimated to provide sufficient land for 100 beds. The proposed buildings consist of a caretaker's cottage with waiting-room alongside, close to the entrance off Gap Road.

Receiving and Discharging Block.—A receiving and discharging block, containing two similar divisions, the one for patients admitted, the other for those discharged. Each division is entered by a door leading into a receiving-room which communicates with a bath-room, on the far side of which is a dressing-room.

Administrative Block.—The administrative block contains three floors with a kitchen annex. The ground floor contains a doctor's room, 11 feet 6 inches by 12 feet 6 inches, off which is the doctor's bath-room, w.c. and surgery; the surgery has a window through which medicine can be supplied. There is a matron's sitting-room, 13 feet by 13 feet 9 inches; an office, pantry, nurses' and servants' sitting-rooms, each 18 feet by

Fig. 1.

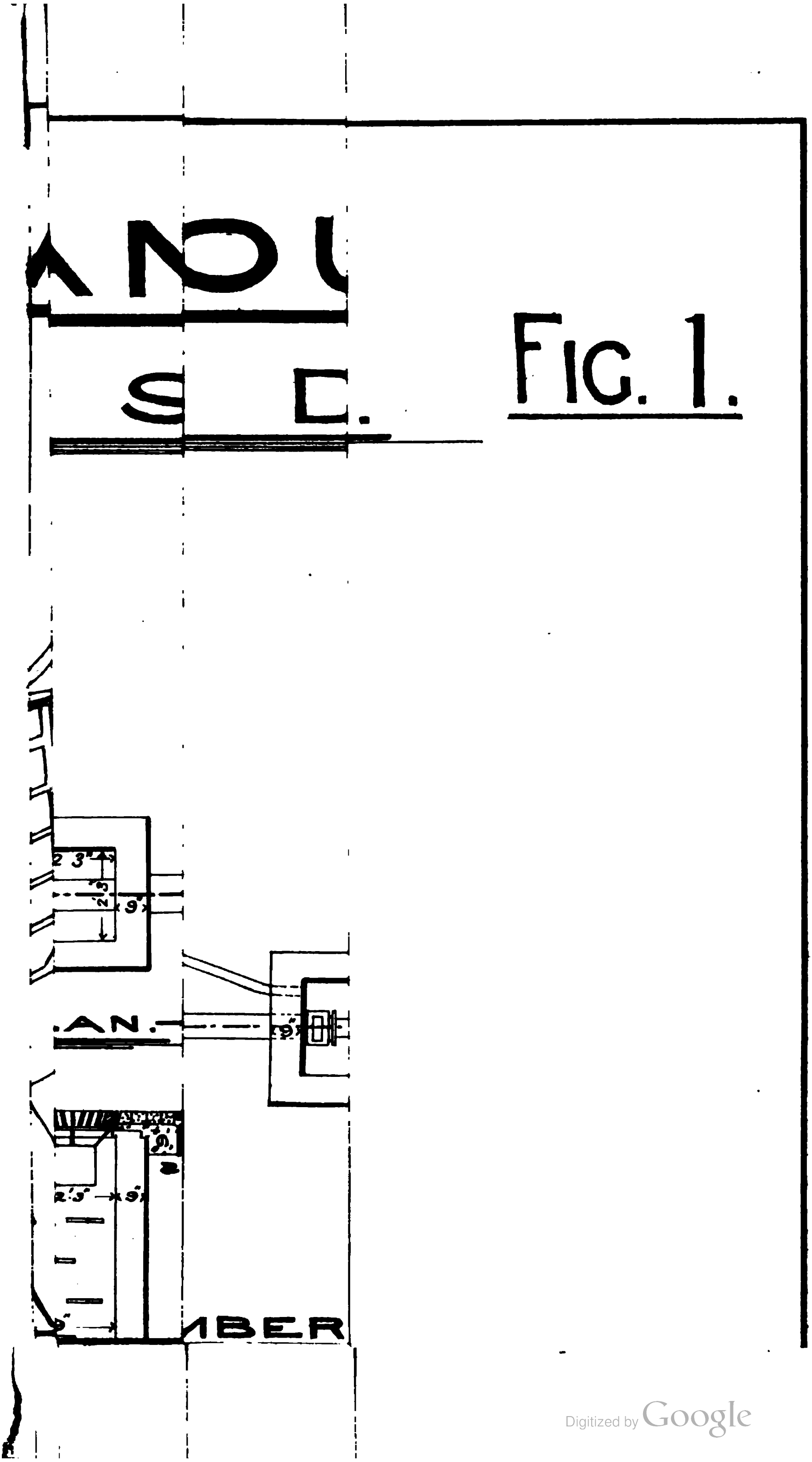
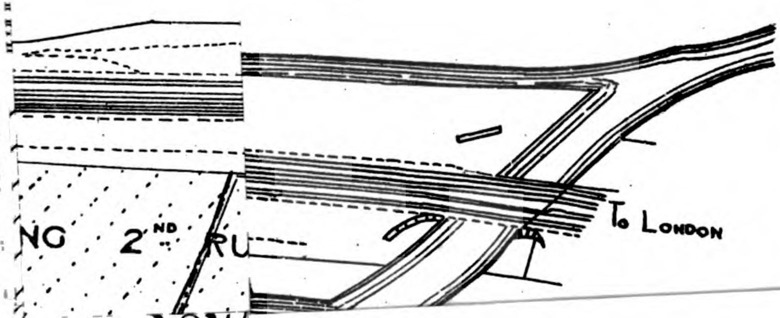


FIG. 2.



Sew

▨ IRRIG

▒

▩ FILTE

▨ STOR

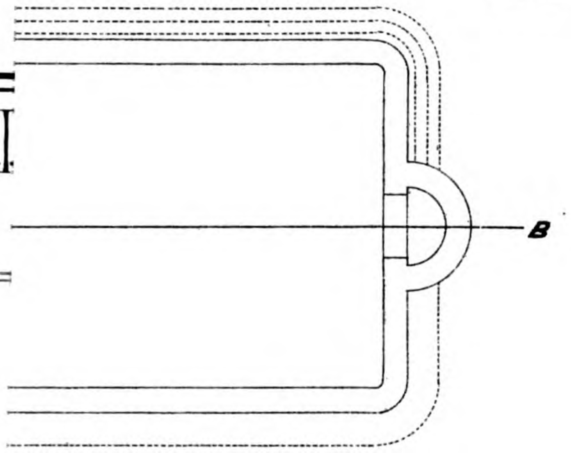
. H. Cooper
A.M.I.C.E.
Engineer & Surveyor

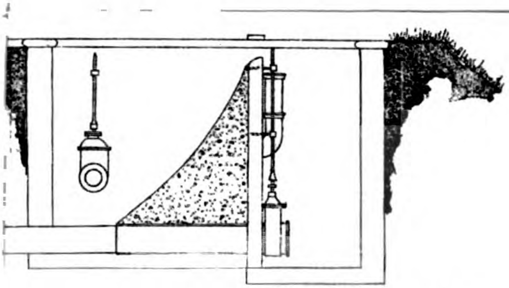
PHOTO-LITHO. SPRAGUE & Cº LTD 4 & 5, EAST HARDING STREET, FETTER LANE, E.

FIG. 3.

CAL

ER T





A A

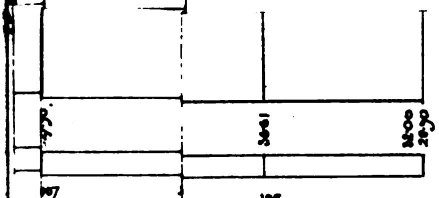
C. H Cooper

A.M.I.C.E.

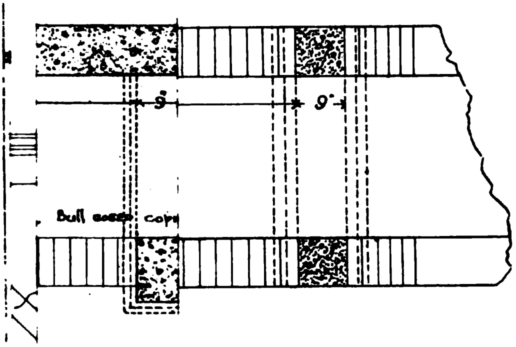
Engineer and Surveyor

17th Dec 1894

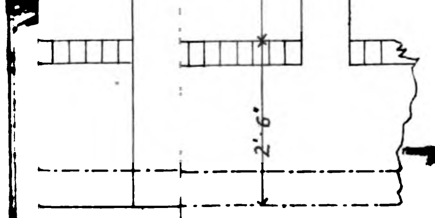
PHOTO-LITHO SPRAGUE & Cº LTD 4 & 5, EAST HARDING STREET, FETTER LANE, E.C.



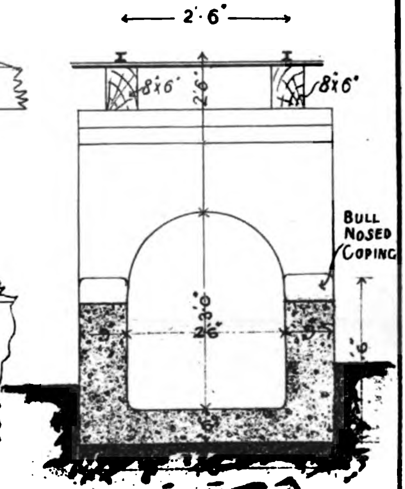
SECTION E.E.



AT D·D·



RRIER AT. D·D·



SECTION

C. H Cooper
AMICE
Engineer Surveyor

Fig. 5.

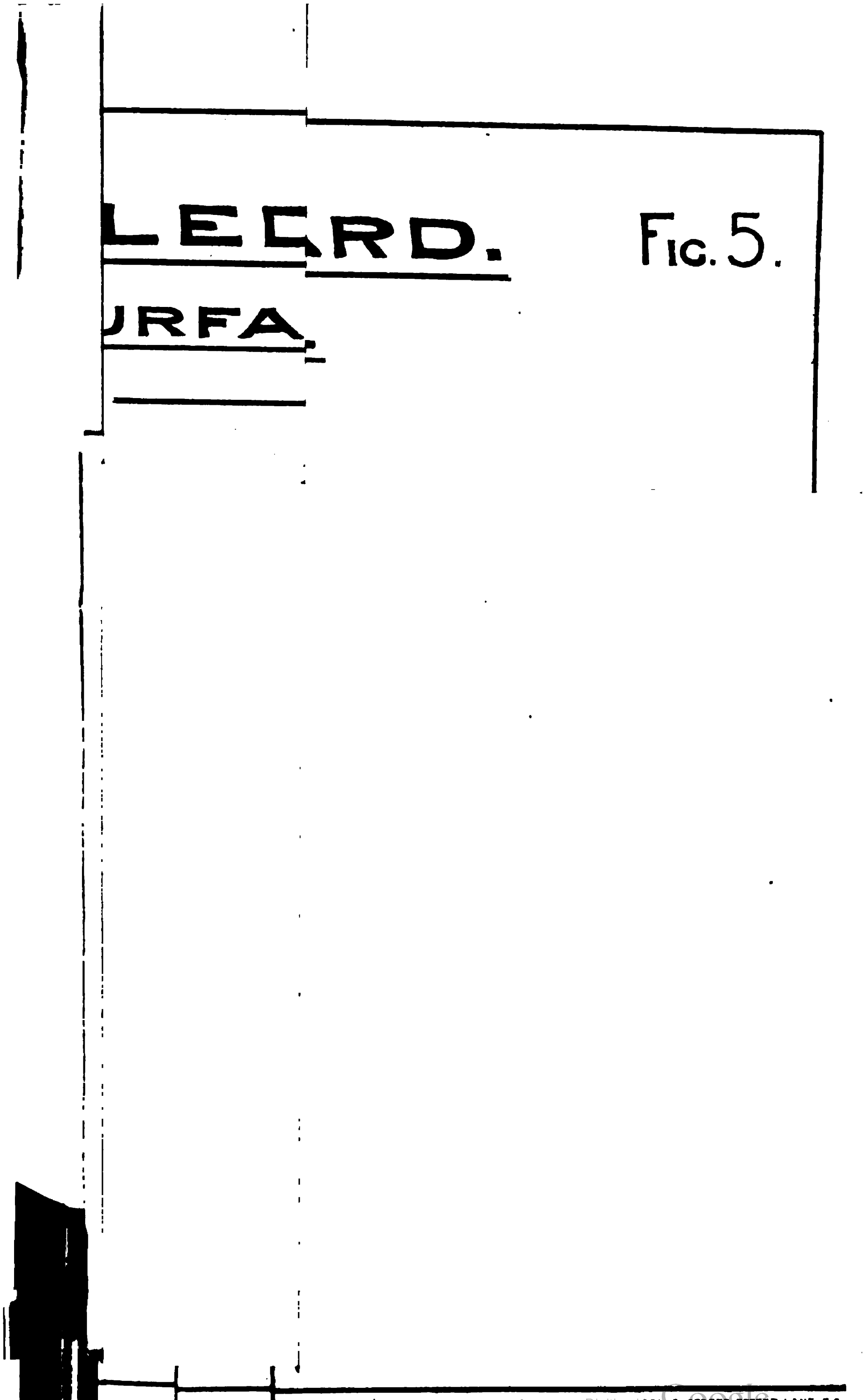
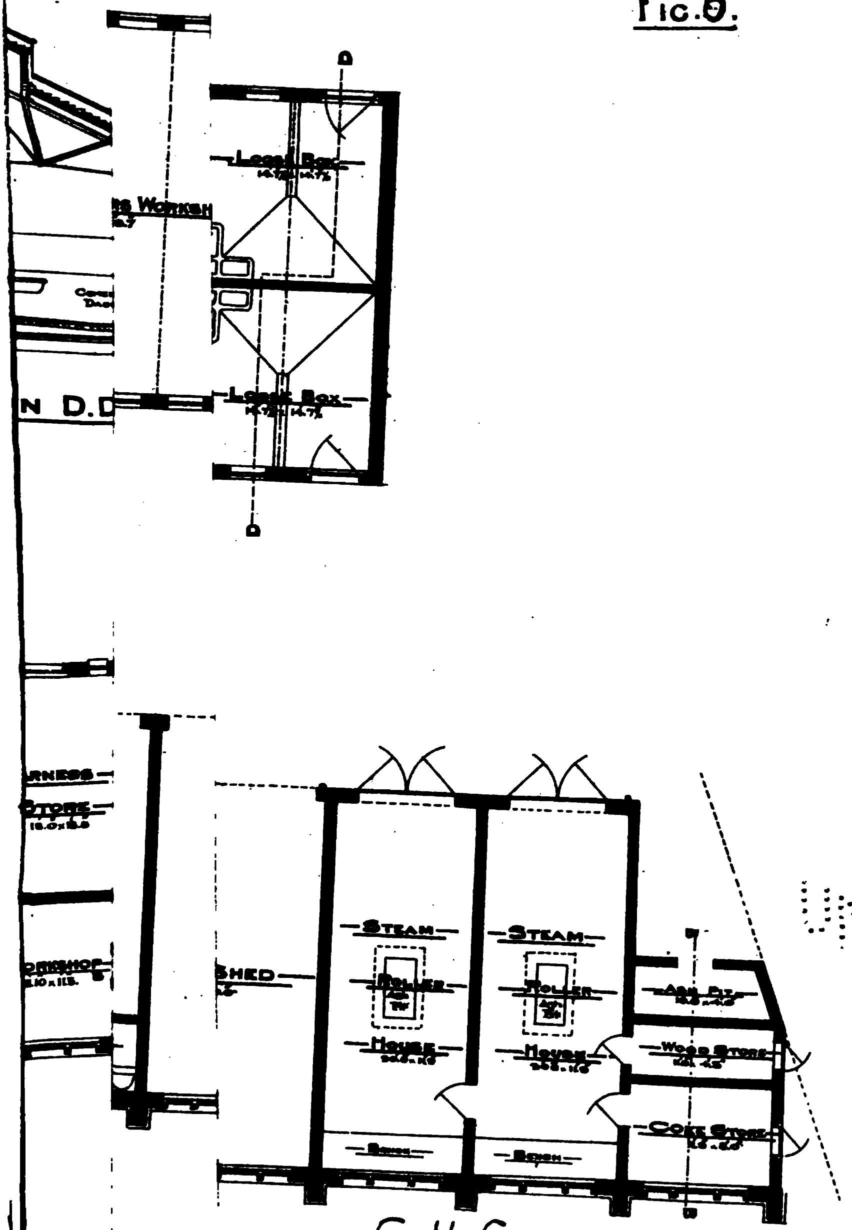


PHOTO-LITHO. SPRAGUE & Cº Lᵀᴰ 4 & 5, EAST HARDING S . FETTER LANE, E

FIG. 8.



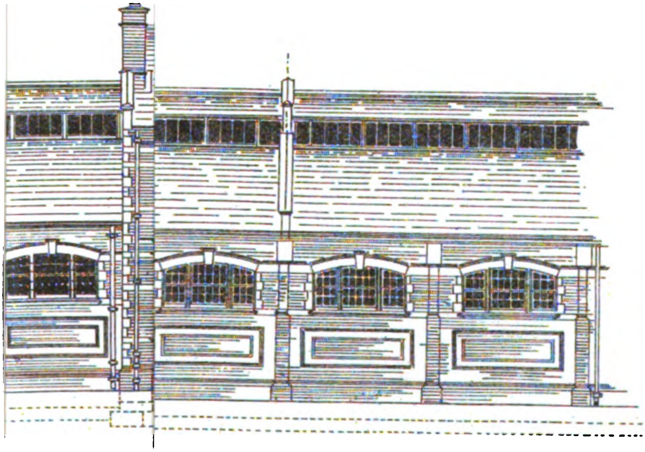
C. H. Cooper
A.M.I.C.E.
Surveyor

PHOTO-LITHO. SPRAGUE & Cº Lᵀᴰ 4 & 5, EAST HARDING STREET, FETTER LANE, E.C

N C

ÔT B

Fig. 7.



C. H. Cooper
A.M.I.C.E.
Surveyor

PHOTO LITHO SPRAGUE & Cº Lᵀᴰ 4 & 5 EAST HARDING STREET, FETTER LANE, E.C

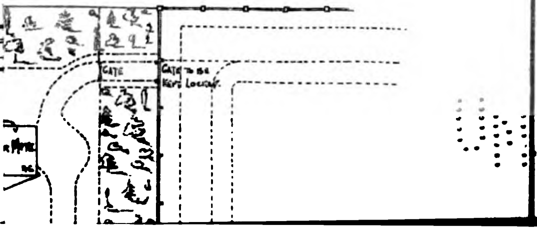
BAN

FOR INF

OF SITI

DRAINAGE.

FIG. 8.

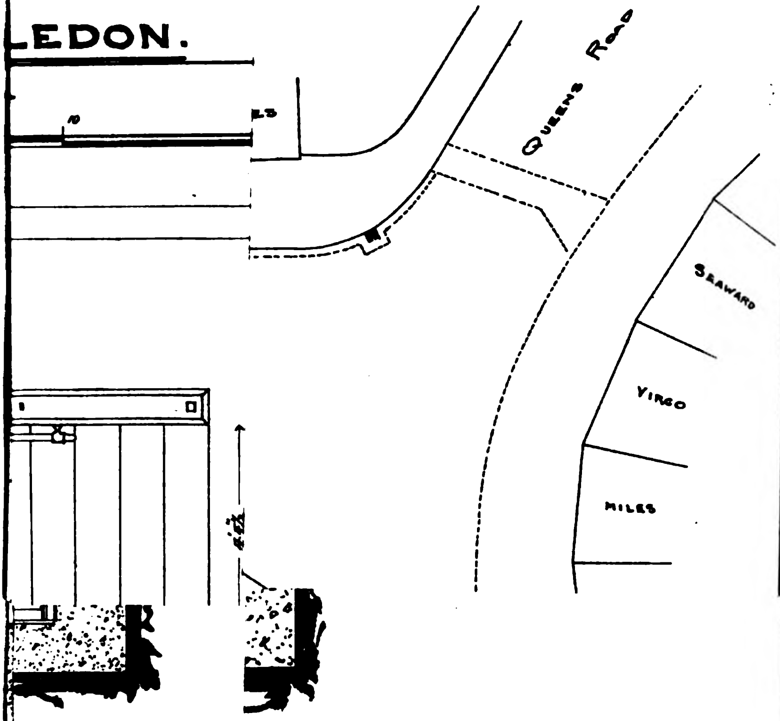


ISTRI

D CONV

LEDON.

FIG. 9.



H. Cooper
A.M.I.C.E.
Engineer Surveyor
9-~~VI~~ 97

PHOTO-LITHO. SPRAGUE & Cº LTD 4 & 5, EAST HARDING STREET, FETTER LANE, E.C.

14 feet. These rooms are all 11 feet in height. The kitchen is 18 feet by 13 feet, and will have a 6-feet range and gas stove; there are two serving-windows, one for food for the ward barrows, the other for the administrative block. The scullery is 13 feet by 8 feet. Part of the roof over the kitchen and scullery is carried up to form a lantern light, and so give as much ventilation as possible. This annex also contains a larder and two stores, and a coal and coke store.

The first floor contains two linen stores, two bath-rooms, two w.cs., a housemaid's sink, a matron's bedroom, two servants' and four nurses' bedrooms. These rooms will have a height of 9 feet.

The second floor contains a housemaid's slop sink, a servants' dormitory, 18 feet 9 inches by 14 feet 4½ inches, two bedrooms for night nurses, and four rooms either for nurses or servants. The minimum mean height will be 8 feet 6 inches.

In the roof there will be two 500-gallon cisterns.

The floors are approached on the east by a staircase 3 feet 6 inches wide, 7-inch rise and 9-inch tread, with an emergency staircase on the west 2 feet wide, 8-inch rise and 7-inch tread. There will be a lift for coal, &c., communicating with the three floors.

Laundry and Disinfecting Block.—The laundry contains a wash-house, 20 feet by 18 feet, with an ironing-room, 25 feet by 18 feet, lighted on both sides, and having a lantern light running along the roof; there is a six-horse dryer off the ironing-room. The disinfecting station consists of a room for infected and one for disinfected clothes, each 12 feet by 14 feet 6 inches, with a Washington Lyon's disinfector placed so as to communicate with both rooms. The laundry is separated from the disinfecting station by an ambulance station, having houses for the ambulance and infected linen cart, and one for the cart for disinfected linen. These houses are divided by a two-stalled stable.

Mortuary.—The mortuary is placed as far as possible from the other buildings, and at a point convenient of access to the cemetery. It is 14 feet by 14 feet, with three shelves on the south side, and a window to view on the north side with inside shutters; there will be a post-mortem table in the centre and a lantern light in the roof.

Pavilions.—There are three ward pavilions: the largest contains in the female side a twelve-bedded ward, 72 feet by 26 feet, with a one-bedded ward 13 feet by 13 feet. The lavatory annex, which is cut off by a vestibule, contains a bath-room, three wash basins, three w.cs., one for the nurses, a slop sink and a dirty linen shoot. The male side is cut off by the nurses' duty-room, hall and small kitchen. The male side has an eight-bedded ward, 48 feet by 26 feet, with a one-bedded ward 13 feet by 13 feet, and lavatory annex similar to that for the female side, except that one closet is replaced by a urinal. The female ward will be heated by two double Shortland stoves, and the eight-bed ward by one of such stoves. In the lavatory annexes there will be radiators.

The second pavilion has eight beds in the female and four in the male ward. The lavatory annexes are similar to those of the twenty-two bed pavilion, except that they are smaller.

The nurses' duty-room is fitted as a ward kitchen.

The third pavilion contains two two-bedded wards, similar to the isolation rooms shown in the Local Government Board Memorandum, except that a closet annex is attached to each ward.

THE
WIMBLEDON ELECTRIC LIGHTING SCHEME.

By A. H. PREECE, Assoc. M. Inst. C.E.,
Electrical Engineer.

Wimbledon was the scene of one of the earliest attempts of the use of electricity for street lighting. In 1884 a long series of experiments were carried out, under the superintendence of Mr. W. H. Preece, C.E., F.R.S., for the Local Board and the City Commissioner of Sewers. Many interesting results were obtained. However, nothing more was done in the matter until 1890, when a license was obtained from the Board of Trade, and a complete scheme was prepared by Mr. W. H. Preece and Mr. Kapp for the lighting of all the streets of Wimbledon, and for the supply of electricity to private houses. For various reasons this scheme fell through, but finally, in 1896, the Author was instructed to prepare a new scheme, which was unanimously adopted by the District Council. After having obtained a Provisional Order from Parliament in 1897, instructions were given to obtain tenders, and within the last two months contracts have been entered into for the carrying out of the scheme. There is every possibility of a supply for public and private lighting being ready by March 1899.

For reasons which it is unnecessary to enter into, the streets have been lighted for many years by oil lamps, which give, on the average, 20 candle-power. It is generally considered that the main streets, at any rate, require better illumination. Oil lamps are cheap, the average cost being about 2*l.* 10*s.*; and thus it has been somewhat difficult to increase the street lighting without increasing the annual cost. The Author, however, hopes to be able to show that there is little reason to expect any great increased cost, though the total quantity of light will be more than doubled.

The present scheme provides for the lighting of the whole of the existing public lamps. There are at present about 800 fixed, and these will be replaced by the equivalent of 900 lamps of 32-candle-power. A certain number of the lamps in important positions will be provided with two or more lamps of 32-candle-power.

Besides these public lamps, which alone will take nearly 200 horse-power, provision is being made for a demand of 6000 lamps of 8 candle-power in private houses.

In order to supply electricity to all the public lamps, it is necessary to lay mains in practically every street in the parish; and, as means will be taken to enable private consumers to be supplied at the same time, it will be possible for every house to obtain a supply if required. Of course, special mains will not at present be laid everywhere for private houses, but, by means of the system adopted, it will be possible without great expense to supplement the mains anywhere, and to enable either public or private lights to be supplied.

SYSTEM.

The system of generating and distributing electricity which has been adopted is that known as the high-pressure alternating-current system. The electrical energy is generated by alternators at a pressure of 2200 volts, and wherever it is required for use in lighting public lamps or private houses it is transformed down to the safe pressure of 200 volts.

This system is the only practical system which can be used in the Wimbledon district, owing to the large area and the scattered houses. By using high pressure it is possible to transmit the energy everywhere with small copper cables, and thus the expenditure is kept within reasonable limits.

The transforming apparatus, which is stationary, and consists of a mass of iron plates surrounded with two windings of copper wire similar to an induction coil, is placed wherever necessary to serve low-pressure circuits for public lamps or distributing mains for private houses, and also in some cases where a large installation has to be supplied. They will be placed in underground chambers of varying sizes, according to the quantity of electricity which has to be transformed. When electricity is distributed by low pressure, the three-wire system will be used with 400 volts across the outer, or 200 volts between each pair of wires.

The disadvantage of the alternating-current system is the necessity of having generating plant running all day and night, as it is not possible to use a storage battery economically. But as the generating works will be placed adjacent to the sewage pumping station, and also in conjunction with dust destructors, this disadvantage will not be so great as usual, as steam will be available throughout the twenty-four hours.

SITE.

The site of the generating works has been fixed on the north-western side of the existing pumping station; the advantage being not only the possible combination of the two plants, but also the extent of the ground available and the existence of repairing-shops, &c.

BUILDINGS.

The buildings will consist, in the first place, of an engine house, about 30 feet wide and 45 feet long, built alongside an existing cottage which will be utilised for offices. A temporary wall will be left at one end, to enable extensions to be conveniently added.

The first boiler house is being built wide enough for dust destructor as well as the boilers, and it will be 45 feet wide and 80 feet long.

The existing coal store will be utilised as far as possible, but when the tipping platform for the refuse is built, a coal store will be arranged beneath.

The chimney will be 120 feet high and 6 feet in diameter inside, and arrangements are being made to have two inlets, so that one line of flues may be cleaned as required without interfering with the working of the plant.

ENGINE ROOM.

The engines and alternators first installed will consist of three Willans engines, coupled direct to three Crompton alternators with exciters. The output of each set will be 120 kilowatts, or approximate 200 indicated horse-power.

The Willans engines are high-speed engines running at 350 revolutions. They are closed in, and lubricate themselves. The alternators have revolving armatures of the disc type. The guaranteed combined efficiency of the plant is to be 80 per cent., and the steam consumption will be 28·5 lbs. per kilowatt.

BOILER HOUSE.

The first plant installed in the boiler house for the generating plant will consist of three Babcock and Wilcox boilers. They are of the water-tube type. Each boiler is guaranteed to evaporate 5000 lbs. of steam per hour, and they each have a heating surface of 1700 square feet, and a grate area of 35 square feet.

To one of the three boilers a dust destructor will be afterwards added, but the remaining two will be kept for hand firing alone. A fourth boiler will be connected to the second dust destructor, and both the destructor boilers will be arranged so that hand firing can be used when required.

CONDENSING PLANT, PUMPS, ETC.

It is not intended to fix a condensing plant at once, but arrangements will be made for the addition of a surface condenser. The pumps and all steam and feed pipes will be arranged in duplicate, so that the failure of any portion shall not affect the working of the plant.

SWITCH-BOARD.

The switch-board, to which the electricity generated by the alternators is taken and thence distributed to the various circuits, will be fixed in the engine room. It will contain all the necessary regulating and recording instruments for the alternators, exciters and circuits.

One pole will be earthed, so that only single-pole switches and fuses are necessary.

The regulating will be done entirely by hand on the switchboard, and with the system adopted it is anticipated that no difficulty will be experienced in providing an equal pressure over the whole district.

A maximum loss of five per cent. is being allowed, and this is arranged so as to be equal in all feeders.

For measuring the energy produced, separate meters will be provided in each of the main feeders, so that a complete record will be kept of the output. It is probable that separate meters will also be provided in the main sub-stations, to record the amount of energy used in the public lamps.

Testing will be carried out by means of standard instruments, which will be fixed in a special room in the offices.

MAINS.

The mains are divided into two sections, the high-pressure and the low-pressure.

The high-pressure mains consist of the feeders or trunk mains, which conduct the energy for public and private lighting to the principal distributing points in the district, and the sub-feeders, which are arranged separately for the public and for the private lighting. Thus at the distributing centres the public lights and the private lights are separately controlled, and are therefore independent of each other.

The whole of the high-pressure feeders and sub-feeders are concentric lead-covered cables. They are drawn into earthenware pipes, and they can thus be increased as the demand in the different districts increases.

There are three distributing centres, and thus three trunk mains. These trunk mains are interconnected in case of accident to any one of them. They are of large area. The sub-feeders are of small area, and each feeder supplies the high-pressure energy along certain routes, and at fixed points it is transformed in sub-stations as required. The sub-stations for the public and the private lights are kept generally distinct from each other.

It is intended that the public lamps shall be turned on and off from the main distributing points, and thus it will only be necessary to send a man to the three points to light up all the streets.

The low-pressure mains are both concentric, and three-core cable, and these are laid on two systems: (*a*) Wherever the demand for private lighting is uncertain, and the pavement is such that it will be somewhat difficult to cut and re-make, pipes are to be laid so that the low pressure for the private lighting and the public lighting may be drawn into the pipe as required. (*b*) Wherever the demand for private lighting is certain to arise, both public and private lighting mains are heavily armoured and laid direct in the ground. Where it is doubtful as to the private lighting demand, and where only gravel pathways exist, public lighting mains only are to be laid, and these will be also armoured and laid direct in the ground.

SUB-STATIONS.

The sub-stations, or transforming points, will be of such a size as is consistent with the demand. In them the transformers will be placed, and also fuses to control the different public lighting circuits. The private lighting sub-stations will be similarly arranged.

PUBLIC LAMPS.

The public lamps will be arranged from five to ten in a circuit, on the three-wire system. Each lamp will be provided with an accessible joint box to facilitate testing and connections, but switches or fuses will not be provided to each lamp.

The lamps are generally 32-candle power, but in the main streets, such as Broadway, Hill Road, High Street, and part of Merton Road and the Ridgway, two or more lamps will be provided in each part.

It is intended to utilise as far as possible the existing oil-lamp posts, which are easily and simply adapted for electric lamps.

It will only be necessary to remove the oil lamps and fix a tripod carrying the glow lamp.

It is not intended at present to use arc lamps anywhere, but it is possible that a few enclosed ones may be experimented with. It is, however, generally found that the mixing of arc and glow lamps tends to considerably reduce the effect of glow lamps, however large, owing to the different colour in the light given.

Expenditure.

The cost of the scheme will be as follows, exclusive of the dust destructors:—

	£
Buildings	3,000
Machinery	8,500
Mains	15,000
Transformers	2,000
Public Lamp Connections	1,100
Private House Connections	600
Engineering and Contingencies	1,800
	£32,000

From the tenders already accepted it is not anticipated that the above estimate will be exceeded.

It will be observed that the expenditure in mains is the most serious item. This is due to the enormous area to be covered. It has been necessary to provide for about 40 miles of streets, involving no less than—

15 miles of high-pressure mains.
50 miles of low-pressure mains.
20 miles of pipes.

Income and Expenditure.

The great advantage of starting an electricity supply works with a large quantity of public lighting is that it ensures a comparatively even output. The generating plant is kept working at a high state of efficiency for many hours, instead of, as is frequently the case in works without public lighting, for two or three hours per day.

In Wimbledon the works are certain of using the plant for the first year or two at 50 per cent. of its full output for an average of ten hours a day; and throughout this time one engine and dynamo will be working at full load, that is, at the best efficiency.

This makes a very large difference in the cost of generating electricity. The Author has hopes of producing energy as low, if not lower, than many stations which have been at work for some years.

The undertaking also starts with an assured income. The present cost of public lighting is about 2000*l.* per annum, and this income will belong to the electricity department.

It has not been expected that the adoption of electricity will effect a reduction in the cost of public lighting, in fact, the Author stated in his report in 1896 that the additional cost will probably be 550*l.* It cannot be considered an excessive increase when it is recollected that the quantity of light is more than doubled.

The revenue from the private lighting is naturally uncertain, but, from the applications and inquiries which are already coming in, there is little doubt that it will not be long before the full capacity of the plant is reached.

Assuming, however, that 5000 lamps are connected, then, with 6*d.* per unit, which has now been agreed upon as the price to be charged, it is a moderate estimate to take the probable income as 1750*l.*, or about 7*s.* 6*d.* per lamp.

The expenditure necessary for lighting the public lamps, and for providing electricity for the 3500 private lamps, can be fairly accurately estimated from results obtained from other undertakings.

The quantity of electricity required to be produced is known, and there is no reason to doubt that it will be possible at Wimbledon to produce electricity as economically as in other works.

At Hammersmith, where the Author has erected works for the Vestry, the result of the first nine months' working shows that the cost per unit, when 40 per cent. of the total output is for public lighting, is 2*d.*

In Wimbledon no less than 80 per cent. of the output will be for public lighting; thus there is every possibility of the cost being even less.

If, however, the costs are taken at 2*d.* per unit, the total annual expenditure to produce the quantity of units required by the public and private lighting will not be less than 2500*l.*

In addition to these costs there are the charges for interest and the sinking fund. This will not be less than 1700*l.* per annum.

Thus the total annual expenditure will be—

	£
Generating costs	2500
Interest and Sinking Fund	1700
	£4200

The revenue would be—

	£
Present cost, Public Lamps	2000
Income from Private Lighting	1750
	3750
Deficit	450
	£4200

That is to say, the extra cost of the improved public lighting will be about 450*l*.

But this is likely to be reduced as the demand for private lighting increases.

If the private lighting is not so great as anticipated above, then the deficit will be slightly greater, and though this may happen in the first twelve months, it is exceedingly doubtful whether the second complete year will not see a larger revenue than is anticipated.

UTILISATION OF HOUSE REFUSE.

This is about to be tried in connection with the electricity works, but it is impossible to be able to state what results will be obtained by the generating plant. It depends greatly on the calorific value of the refuse. In any case, however, the District Council will be able to get rid of the refuse cheaply.

The destructor is necessary, and a combination of the electricity works and the destructor is therefore economical as regards capital expenditure, and likely to be of value in the combination of two stoking staffs.

There is little doubt that a certain quantity of heat will be available from the destructors, but during the evening it is not likely to be sufficient to produce all the steam required for the generating plant. However, in the day-time, and perhaps after midnight, the steam generated from the dust should be sufficient to supply both the pumping works and the electricity supply works.

This alone should reduce the annual expenditure in coal.

Therefore, even if the question is looked at from an entirely unbiassed point, it seems that there is every possibility, if not probability, of great advantages being obtained.

The Author has no reason to doubt that it will be shown that the streets of Wimbledon will be economically and well lighted by electricity, that the private supply will be largely taken up, and that the destruction of the refuse will enable the ratepayers to get full benefit from the investment of the moneys under their control in these commercial undertakings.

ELECTRIC WIRING PRACTICE.

By FRED. BATHURST, Assoc. Inst. E.E.

There are to-day in England, either in operation or in course of erection, over 200 central electricity stations, which are capable of supplying upwards of 300,000 horse-power of electrical energy, and which can be utilised for the purposes of lighting, heating and motive power. The above figures will show that every town of importance has now the means of providing for the public a supply of electricity, and we may take it that nearly 50 per cent. of these central stations are directly under municipal control. Although the Members of the Association we have to-day the pleasure of welcoming, may not be immediately directing these "depôts of power," they must, nevertheless, by reason of the prominent directive positions they hold in our towns and boroughs, find it necessary to acquaint themselves with the general trend of the practice connected with these latest adjuncts to present-day town life.

Granted therefore, that electricity supply is available to every householder living in an up-to-date town, the problem with which we are now about to concern ourselves is how best to install the conducting wires on the consumer's premises with due regard to safety and convenience. In other words, we are to enquire into the conditions affecting or governing the "interior electrical wiring," by which the electricity supplied from the street main is conveyed to its points of utilisation within the house, be it for incandescing an electric glow lamp for lighting, heating an electric radiator for warmth, or driving an electric motor for power.

To-day the greater part of the above 300,000 horse-power is utilised for lighting purposes only, and when we consider that the three million incandescent lamps already supplied from central stations represent the accomplishment only, of perhaps *one per cent.* of the total lighting which is carried out in towns, we gain an idea of the immense field still open to electricity in this particular sphere of utilisation. Knowing, further, the steady and continued progress electric lighting is all the while making, we must recognise that the question as to whether electric wiring in the nature of its installation is good or bad, whether it is temporary or permanent, is a matter of great and increasing importance. We may take it, in fact, that the position of the art of wiring dominates the progress of extended electrical application, and affects the immediate prosperity as well as the future of the whole electrical industry.

CONDITIONS.

It is now generally understood that when electrical wires are imperfectly installed, the electricity escaping from them can under suitable (and too liable conditions) set fire to its surroundings; and, knowing that fires caused by electrical means are so insidious in their character that their very mention breathes danger and alarm, it will be instructive, before directly considering the present practice of wiring, to briefly review a few of the conditions which create or remove the possibility of danger, and gain some idea of the principles which underlie effective construction.

Conducting wires, although designed with the intention of carrying current proportionate to their sectional area, will, if permitted, carry any current that is passed through them, becoming over-heated in so doing and damaging any insulating covering that may be upon them. This possibility of their being able to set fire to their covering, and the ultimate fusion of the conductor itself, can be readily shown by experiment. (Experiment shown.)

Having, therefore, an ordinary insulated electric wire carrying current, we must face the possibility of injury occurring to it *from within itself*, and note that in this respect the condition of electric service is very different to that we are accustomed to in gas practice.

As supporting the method of wiring the author will advocate, we will here make the experiment of arranging the insulation in the form of a tube which directly surrounds the conductor but without being immediately attached to it. You will here note that, although under the same conditions as before, the conductor can now be burnt out inside *the tube* without its destruction. (Experiment shown.)

Comparing our first case of an electric wire and its tight-fitting insulating covering with a gas pipe, we see that the copper conductor is equivalent to the orifice of a gas pipe, whilst the frail insulating covering has to be compared with the coating material forming the gas tube. As regards mechanical considerations, therefore, a rubber insulated electric wire installed in a house without other protection compares with a gas service furnished through rubber tubes; and it is unnecessary to add that a gas supply of the latter nature, although perhaps permissible for a temporary connection, would not be countenanced in standard practice. Some might here argue that so-called "safety fuses" are put in circuit with electrical conductors in order to protect them from becoming overheated, but commercially these fuses generally consist of a short length of easily fusible tin, or tin-lead alloy wire, and they are found to have great limitations. In the first place, no satisfactory form of fuse-holder has been devised that prevents the enlargement of its capacity by careless or uninitiated persons, and it is common experience to find that when a fuse is continually breaking the recurrence of this trouble is prevented by replacing the tin wire by one of iron or copper, which will carry any excess of current. A certain sized tin or alloy wire, which will act as a fuse for a steady current of certain value, will momentarily allow a very much larger current to pass (the fuse acting with a steady current of ten amperes may on "short circuit" permit a momentary rush of fifty or more amperes), and this time-integral further varies with the same sized fuse wire in fuse terminals of different makers. Further, a fuse of fixed capacity affords no protection against "leakage" current so long as this current does not exceed that of the fuse capacity, and a later experiment will show how an electrical fire can result from a current which is not capable of breaking a small fuse, although it is one in which the limit of physical strength is very nearly approached.

Returning to our experiment, we see that it is the intactness of the coating of insulating material which confines the current to the conductors, and that the "insulation" of a conducting wire must be correctly designed and proportioned to the tendency to leakage.

Electricity is supplied to the wire at a certain pressure, or voltage, and this factor also determines the ability of the current to break through the insulating environment, for just as "pressure" (the number of lbs. per square inch), in the case of steam or water, can be raised so as to burst a metallic pipe, so can the voltage of the current on a conductor be increased until the insulating covering is broken down.

Here, still, in comparison with gas service, we find electricity again at a disadvantage, for, although the insulating material may be properly designed to withstand the voltage with the material in a perfectly dry state, the slightest unforeshadowed presence of moisture can act disastrously and cause the insulating material to lose its electrical value. This fact can be brought home to our bodily senses by first of all touching the charged conductor, which is protected by a coating of dry cotton, and then touching the same conductor when the cotton has been wetted. This fact can be determined by anyone desirous of testing it. (Experiment shown.)

There is a further condition in electrical work, that when the insulating covering of a wire becomes partially damaged, the escaping current not only chars and destroys its covering, but creates an electrolytic effect on the conductor itself, which results in its gradual corrosion and a corresponding decreased carrying capacity, until ultimately a condition is arrived at when the conductor is not large enough to carry the current it was designed for. The very first requirement, therefore, in providing for "insulation" is to rigorously exclude the possibility of moisture reaching the conductors; and, in looking for suitable materials for insulation (porcelain, mineral wax, oils, rubber, dry silk and cotton are insulators, whilst all metallic bodies are usually good conductors), we have not only to find good non-conductors, but choose those materials which are resistant and repellent to the effects of moisture.

We have now gained an idea of the importance of the considerations underlying the question of insulating conductors, and noted that the direct insulating covering of an electrical wire is exposed to possible injury both from within and without, and that in providing perfect protection, we have to guard against certain electrical, chemical and mechanical conditions.

India-rubber, now the generally used standard material for insulating light wires, whether applied in its pure and plastic state or in its vulcanised condition, has, it must be allowed, a certain limited life, but as to what time is the exact duration of its life, under the varying conditions of wiring application, is a matter too contentious to deal with here. But, sooner or later, under the ordinary atmospheric conditions, it deteriorates, becoming dry and brittle, so that cracks and air checks appear and present the chance for any collection of moisture in its vicinity to give rise to electrical faults. The acids and alkalies of the cements and plasters used in connection with building construction are also known to act upon rubber and the fibrous material used in insulating electric wires, so as to cause their deterioration and destruction. The rubber insulation should, therefore, be protected, as far as possible, against deterioration, and, failing absolute protection, arrangements should be made to prevent its deterioration from causing injury outside the electrical conductors themselves. In this connection, does not the experiment with insulation in the form of a tube offer a feature of safety, and a supplementary possibility of increased durability that deserves to be worked out commercially?

SYSTEMS OF DISTRIBUTION.

Dealing for a moment with the plans upon which the wires may be installed, before coming to the actual modes of erection, we have to note that the term "circuit" as applied to electric light wiring implies the use of two distinct wires, which are usually laid close together, one being used as the "lead" and the other for the "return" of the current to the point of generation. Comparing them still with the familiar gas practice, which requires only the single pipe connection to the individual gas jet, where the gas is ignited in contact with the air, the idea of the construction required in electrical work can best be grasped by imagining it necessary to provide a second and supplementary system of piping, just as if an exhaust system of piping were necessary to collect the products of combustion in order to return them to the gasometer. Electric circuits can be installed either on a "tree" principle or on a "centre of distribution" principle. In the former, the current may be taken as circulating in the wiring as the blood does in our bodies, passing from the larger arteries to smaller ones (branches) and ramifying (in circuits) throughout the system, like the branches of a tree, and according to the direct needs of the parts, eventually being returned towards the starting-point, the heart, by the veins. By this method, as fuses are placed wherever a small wire joins a larger one, in order that the current-carrying capacity of the smaller wire may be protected, it often happens that the fuse boxes are placed in unlikely and inconvenient positions, and generally only on one pole, the positive lead, the exigencies of space and appearance prohibiting large and unsightly appliances. This principle was almost universal in the early days of wiring, and in some few cases is still adopted, but it is being, and should be, entirely superseded in favour of the second principle, that of "centres of distribution."

Under this plan a number of main conductors pass off towards the various parts where supply is required, terminating at certain fixed and convenient points, from which as many of the small branches as may be required are run off to groups of, or even to each of, the individual outlet points. It is obvious that this principle provides convenient centres for the general assembly of safety fuses, which can be placed on both poles, and definite positions from which faults on any individual branch can be tested. In practice it permits the use of the minimum number of fuses required, and reduces the changes in the size of the conductors to the smallest number. It greatly simplifies the calculations as to the sizes of conductors required, besides making the work of installation easier of execution by lessening the number of joints required to be made (every joint in a conductor being a source of weakness), and reduces the possibility of inferior workmanship. Further, it gives the most constant voltage at the lamp terminals, with their corresponding advantage of increased life, without regard to how the lamps in different parts of the building may at different times be operated.

This is, in fact, the best principle of distribution and control that can be adopted.

PRACTICE.

Leaving theoretical and coming to actual practice, if we take the year 1889 as the date when central stations work really began to be energetically undertaken, we see that nearly ten years have elapsed since the possibility of central electrical supply, and yet—shame to the electricians to have to own it—

we cannot yet point to a permanent and satisfactory system of wiring that can be called as "standard," as iron piping work can be termed in respect to gas practice. Professor S. P. Thompson has, in his practical and epigrammatic way (in a paper read before the Society of Arts), said, that what is wanted is a system of electrical conductors which will be "electric-tight," "water-tight," "gas-tight," "air-tight," "oil-tight" and "rat-tight," and with these qualities we shall doubtless attain that "tightness" which goes with first-class electric work. The fulfilment of these conditions would seem to indicate that the wires must be well arranged mechanically, and as in ordinary building construction they have to be fastened on walls and ceilings, pass under floors, and through brick walls and other partitions, the Author would suggest that these "tight" requirements at once point to the value of a "tube" or "conduit" system of wiring, as providing a means of inserting and readily withdrawing the conducting wires, in addition to the protective value such a system of piping affords, for preventing disturbance of, and injury to, the conductors placed within it. A conduit system furthermore lends itself perfectly to the "distribution centre" method of installation.

Inasmuch as telegraphic experience preceded the application of electricity to lighting, electricians naturally followed the ideas prevalent in that class of work, and first employed such wires as were commercially available, and which were, comparatively to the requirements which had to be filled, but lightly insulated. Wires covered with cotton soaked in paraffin wax were used; and in the absence of any definite experience with the larger current units being handled, we can now see that, in the then state of the art, it was only to be expected that with these wires just tacked or stapled up in position, and passing without method or order through floors and along walls, "overheating" and "leakage" troubles were likely to result. An experiment has been here arranged, by which it will be seen how easily two wires, connected with a source of electrical supply, and which are but lightly insulated, or in which the insulating covering has been damaged, can, when lying on damp wood, cause a fire. (Experiment shown.) You thus see the quiet and insidious way in which an electric fire is caused.

The moisture has acted as a conducting bridge between the two wires with the result that, what was at first a small leakage has rapidly become worse, resulting in the complete destruction, charring, and ultimate firing of the inflammable rubber or other insulating covering on the wire, and the firing of the wood or other combustible material in its immediate neighbourhood.

From this experiment it is evident that all electrical conductors installed on this or similar lines, should be in sight, or, if concealed, readily "accessible," or capable of easy removal for inspection or replacement. For if they are in any way fixed and "inaccessible," the faults which may arise on them are equally fixed and inaccessible. You will note also, that the above results are possible in spite of the protection (?) afforded by a 3-ampere fuse, and further, that the leakage action could be taking place between the wires without having any lamps alight on the circuit.

The action which was taken from 1889 to 1890 by the Fire Offices, if not based directly on experience, must, however, in the light of present circumstances, be taken as effective. Rules were drawn up, and for some considerable time contractors felt the pleasures of what (if the Author may be allowed to use the word) they now consider "stepmotherly" solicitude and attention. Then came the palmy days of "wood-casing," and such insulated wires only as met with "approval" could be installed, whilst slate, asbestos and other auxiliaries could not be employed too lavishly. New editions of rules followed one another with startling rapidity, in order to keep up with the state of the art, and even to-day we still feel the effect of the many anomalies which exist from those times.

Be it for want of authoritative encouragement and support, or be it British conservatism and apathy to try anything "new" when an apparently satisfactory method already exists, the fact remains that in England wood-casing construction still holds the general field. In the desire to obtain low cost wiring, the prices of the material used have been forced down to the lowest point, and, in the keen competition now existing, the only hope of reducing the cost of the installation must rest in lessening the cost of the workmanship. The boxing-in of wires and joints can evidently tend to the existence of slipshod and shoddy work, and work can be done that will for the moment be able to pass all the standards required by Fire Offices and Central Stations because no method of testing determines how long such work will stand.

The unscrupulous wiring contractor knows the difficulty of visual examination and how seldom it can be effectively carried out, and is thus, if he chooses, placed in the position of competing with a reliable contractor by reducing the quality of his material or workmanship; and, considering the inherent difficulty of exactly estimating the labour, the Author thinks that it is these conditions which are answerable for the immense variations we see to-day between the tenders submitted for wiring work. In some cases the prices tendered vary from 100 to 200 per cent. on either side of the estimated figure.

Some advocates maintain that wood casing, although it cannot be called "permanent," is, under certain conditions, sufficiently satisfactory, but best of all, cheap. The Author believes that its extended use has caused the art of wiring to so far turn off the right lines that further progress towards cheaper wiring is now barred. He is inclined to think that the future will produce a system of wiring in which far more suitable if at first more costly material will be used, so as to enable the end in view to be accomplished more directly, under a simplified method and with reduced cost in labour. In Germany, for instance, wood casing is now prohibited, and it is also practically obsolete in the United States of America, where the enlarged sphere of electrical application has provided extended experience. For cheap work, preference has now been given in both these countries to insulated conductors, which are run in sight, side by side, at a predetermined distance, upon porcelain knobs or cleats, the principle being to treat the conductors as if they were bare wires. Providing the wires are nowhere concealed, and the conditions are such that they are not likely to be touched or disturbed, this practice has been proved perfectly satisfactory, and less costly than wood casing work.

The increasing demand in England for low cost wiring has recently brought into use a system which can be compared with gas practice employing *lead compo* piping. The two conductors are insulated, laid side by side, and for mechanical protection are provided with a lead covering. This lead cover, it is advocated, provides a more effective protection than wood casing, so that the wire may be directly fastened up to walls and ceilings without further precautions. The flexibility of the wire, and the simplicity of this practice, may at first sight seem to recommend it, and perhaps an extended use may be made of this material for surface work, or where conditions allow of its use, as, if it can be readily inspected, any changes of the presupposed conditions that are likely to injuriously affect the lead covering can be noted, and the suitable precautions taken.

The Author's experience, however, with lead-covered electric wires directly embedded in plaster has been a painful and costly one. The lead covering usually employed is but a fraction of the thickness of ordinary compo pipe, and when utilised under electrical conditions, seems to be liable to rapid deterioration in the strong chemical cements and plasters now commonly employed in building construction. The thin lead covering further presents but little opposition to possible mechanical damage, and once its integrity and waterproof qualities are destroyed, electrical faults soon follow. Where it is placed between floors and ceilings, it is not only liable to trouble at the point of the carpenter's nail, but is exposed to the capricious attention of the familiar house rodent; for just as rats and mice occasionally pay attention to lead-covered gas or water pipes, so they will exert their energies upon lead-covered electric wires, and nothing short of what may be a fateful experience to them and the property owner, will enable them to discriminate between the effect of destroying the continuity of an electrical covering and that of a water pipe. Some *additional* form of protecting shield would therefore appear desirable to the permanence of this class of wiring work.

As affecting this question of surface wiring, however, and outside the possibilities of accidental damage which such work must always present, is the rapidly growing feeling that the work of the present day electrician is unsightly, and perhaps often fatal to any attempt at decorative effect. For, knowing the uncertainty which exists if his wires have to be concealed, the electrician has hitherto sought to gain *carte blanche* in respect to his action within the building he is wiring, and obtains permission to carry out his plans after his fellow-workmen—the builder, plasterer, pipe-fitter and decorator—have left; this, whilst naturally favourable to him, does not always redound to the complete satisfaction of his fellow-workmen. This experience is simply a repetition of what occurred upon the introduction of gas service, and was not satisfactorily removed until the introduction of iron gas piping, which minimised the possible dangers affecting the gasfitter's work, and brought about the present standard practice of *concealed* work. To meet accidental injury from the nails, chisels and saws of his fellow-workmen, the electrician is driven to use *iron* to resist *iron*, and to-day we can note a considerable extension in the more mechanical but more costly practice of placing the electric wires within ordinary iron pipes. The Author does not question the fact that good electrical work *may* be carried out with plain iron pipes, but emphatically urges his belief that this is only the *intermediate stage* we must pass through to secure a standard method of electric wiring.

Iron piping is undoubtedly suited to gas work, but some of its characteristics must be modified to render it completely suitable for electrical work. When wires are run in plain iron pipes, the freedom of the system from trouble and accident depends *entirely* upon the perfection of the insulating coverings surrounding each wire, conditions which, as we have already seen, are by no means easily secured.

It can be shown that any internal roughness in the pipe itself, or the slightest carelessness with the wire itself whilst it it is being drawn into the pipe, can result in damage to the insulation of the wire. Every practical man knows that when an iron pipe is severed by means of the pipe-cutter, a jagged and sharp inwardly projecting "burr" is raised, and the inside diameter of the pipe is slightly lessened. A short run of plain pipe with one or two bends in it is here arranged, the lengths having been cut up and installed in the manner which would be adopted for gas work, and two wires will be pulled through them. (Experiment shown.)

It is evident that the roughness of the edges within the pipe is sufficient to seriously damage the insulating covering of the wires, and unless this is found out at the time, the wires will not have on them the perfect covering they were intended to have. The erection of plain iron piping for the reception of wires, therefore, implies that whenever the workman cuts his lengths he must rigorously care for and ream out the ends quite smooth. Here, then, is a condition which must be squarely faced in order to counteract any carelessness on the part of the workman.

Experience shows that iron pipes exposed to the presence of moisture or changing atmospheric conditions are liable to "sweat" inside, and when such internal condensation of moisture occurs any defects in the insulating covering of the wires will rapidly develop. Any tests that we can now apply after completion of the wiring work will not indicate partial deterioration of the insulation, so that although breakdowns may not immediately result, "faults" *can* be left on the wires or in the pipe until the occurrence of the further conditions, which will cause them to show up. In fact, the plain iron tube being a conductor enables the metal pipe to act as a bridge by which the fault occurring in the insulation of one wire is transmitted throughout the system, to await the breaking down of the opposite wire at some other point. A series of experiments has been arranged to illustrate what may happen when such faults occur. (Experiment shown, see Fig. 1.)

The wires taken are the sizes employed as electrical mains for ordinary house supplies, and are protected by the usual safety fuses of 50 to 100 ampere capacity. Reproducing the conditions which will result in connecting both conductors to the pipe, we see that the effect of the "short circuit" caused may be to burn out the pipe, in spite of the protection supposed to be afforded by the fuses. Although a better idea of the result is gained from watching the practical experiment, the illustration shown herewith (Fig. 1) indicates clearly the results attained.

You will note that the current which momentarily passed the 50-ampere fuse before causing it to operate, made the pipe *red hot*, and nearly melted out a portion of the metal. By the current passing the 75-ampere fuse you will see that a hole is completely "burnt out" of the pipe. In the case of the 100-ampere fuse the effect is still more marked, and with the 150-ampere fuse the limit of illustration with this pipe is reached, inasmuch as the "short circuit" effect of larger currents would leave no pipe at all!

It is unnecessary to dwell upon the fact that the above possibilities would create a very serious fire-risk in those buildings wherein such construction might be found, and that this same state of affairs can be reproduced on all the smaller branches of a *plain iron pipe* system of wiring, if the original fuses protecting the wires have been accidentally enlarged through replacement by careless or uninitiated persons.

In America some experiences of the above kind led the fire underwriters to entirely prohibit the use of plain iron pipe for electrical work; but the Author must, in fairness to the advocates of the plain iron pipe system, admit that the representations of those demanding lower cost wiring have, at the time of this writing, led to a modification of the above rule, so as to admit the use of plain pipe, providing the wires are always drawn in after the erection of the pipe, and that the wires used are provided with a substantial additional fibrous braiding $\frac{1}{32}$ of an inch thick. This extra cotton braiding has to be provided for the purpose of enabling the insulation on the conductors to resist abrasion. Whilst technically, therefore, the use of plain iron pipe is allowed, the practical result of the above stipulation is to force the contractors to prefer as the alternative method the use of an insulated iron pipe; for, although an insulated iron pipe must necessarily cost more than plain iron pipe of equal size, if the wires used in connection with the latter have to be specially treated in respect to their covering, the extra cost involved in this case is a set-off against that of the lined pipe, and the advantage of possible competition is secured.

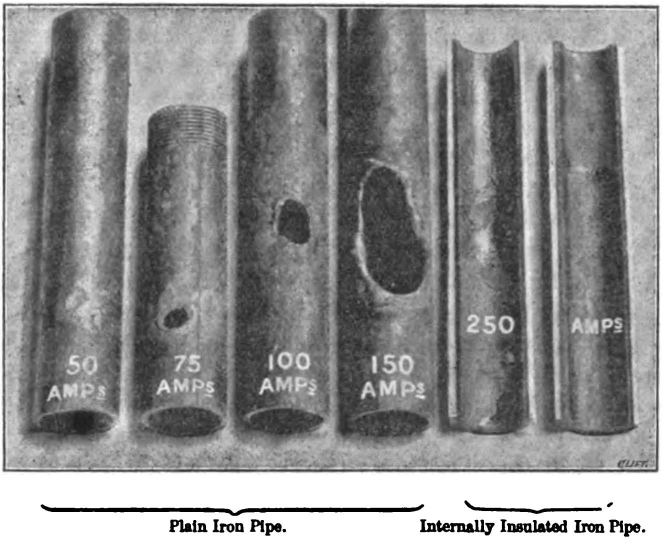


FIG. 1.—Showing the effects of "short circuits" in plain iron pipes and in iron pipes lined with insulating material.

But this question of an insulating lining brings us to the matter which is nearest to us. To prove the electrical value and utility of the "insulating lined conduit," which the members of this Association will see manufactured at these works, we will repeat the short-circuit experiment made with plain iron pipe. In this case, however, instead of the 50 to 150-ampere fuses, we will make a more severe trial and insert those of 250 amperes capacity. (Experiment shown.) This time the result is not pyrotechnical, and examination of the tube will show that the "short-circuit effect" has been kept entirely within the tube. The insulating lining has, it is true, suffered somewhat from the intense internal heat, but has successfully resisted being "burnt out." The tube, when cut open longitudinally, has the appearance shown in Fig. 1 on the right-hand side of the "burnt out" plain iron pipe. From an electrician's point of view the insulated pipe is therefore advantageous, for, being "arc-proof," it safely confines within itself the dangerous fire effects which may result in consequence of the deterioration or injury of the insulation of the electrical conductors.

The Author explains the matter by stating that the insulating lining employed is sufficiently fire-resistant to preserve intact the insulation of the conductors from the metallic pipe, so as to cause the short circuit rush of current to occur *between the conductors themselves*, until either the molten state of the conductors at their point of contact or the rupture of the fuse itself, serves to break the continuity of the circuit and restore normal conditions.

Touching, further, upon the necessity of obtaining in any electrical wire-way or conduit a perfectly smooth interior, so that the wires may be drawn in easily, an experiment has been arranged to show the relative internal friction of lined and unlined pipe, and which results entirely in favour of the former. (Experiment shown.) The effect of carelessness on the part of the installing wireman is also provided against, by the choice of a sufficiently thick and suitable lining, for, upon examination of the samples before you, it will be found that, no matter how carelessly the lined pipe may have been cut, the inner edge of its iron armouring only imbeds itself partly into the lining, and can in no instance cut through it so as to present an internal roughness which would abrade wires being drawn through the conduit. Fig. 2 shows the respective sections of lined and unlined pipe when cut.

The insulating lining reduces to a minimum the condensation that can occur in an iron pipe, and, as no rusting or corroding effect takes place in consequence of whatever moisture does get inside the conduit, it is in this respect superior to plain metallic pipe. The lined pipes are non-hygroscopic, and after being soaked in water will be found to give very high insulation resistance to a bare electrical conductor placed within them; and the insulation can be classed as *permanent* because it is everywhere under the protection of the substantial iron armouring, and is therefore capable of resisting mechanical damage.

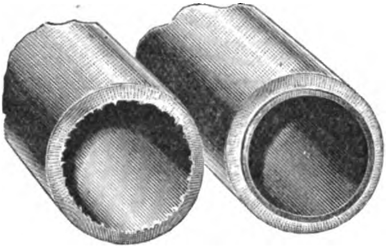


FIG. 2.—Showing the appearance of plain iron and insulated iron pipe when cut.

CONCLUSION.

There are many other features of good electric wiring practice which could be referred to, but which hardly come within the scope of this paper. The Author hopes that he has successfully pointed out that a system of electric wiring which employs continuous tubes or "conduits" of armoured insulating material, has many points to recommend it; that such "electrical" tubes can with complete confidence be installed throughout a building, in the same manner as gas or water pipes, and the conducting wires can be drawn through them afterwards. By this method the wires are insulated electrically from all the materials such as wood, plaster, stonework, gas and water pipes employed in the building itself, with certainty and security. Further, that an insulating conduit system of wiring either guards against or makes satisfactory provision for, any sort of electrical accident which may arise in an electrical installation either from carelessness or ignorance, fully meeting all the conditions required for complete immunity from fire risk, and for personal safety.

In fact, an insulating conduit system of wiring provides in the highest degree the cardinal points of good electrical wiring, viz. "safety," "durability," "convenience," "accessibility" and "economy."

The Author has only to add that the material manufactured by this Company is securing wide recognition in the highest class of electrical installation work, and, in concluding, offers his thanks to the Association of County and Municipal Engineers for having had the privilege of bringing the subject of electrical wiring practice before them.

DISCUSSION.

The **Chairman**: I beg to move a vote of thanks to Mr. Cooper and Mr. Preece for their papers. With regard to the electric lighting I will make a few observations now, because we shall probably not see so much of that as of Mr. Cooper's work. It is a gratifying coincidence that Mr. Preece has taken the view with regard to public lighting that I have advocated for some years. For a long time many experts have advocated public lighting by the series system of incandescent lamps. That is a high-pressure current passing through a number of lamps in series, but the disadvantage is that if one lamp fails a series of lamps would be extinguished unless each lantern is provided with a spare lamp, and an elaborate cut-in arrangement. I have seen that system in operation in several towns in America, and at Windermere in England. I have always advocated the system of lighting in parallel. It is a much simpler and more flexible system, and can be adopted at less cost, especially with alternating current supply, than is possible with lighting in series. I am very pleased to have the support of Mr. Preece on the system which I have had in operation for some time in Hanley. Indeed, I believe I was the first to adopt, to any large extent, the system of lighting glow lamps in parallel. Some advocate the use of a switch to each lamp, because we might as well send a man round to light the lamp as send him round to see if they are lighted. I have not found any such necessity, consequently I am pleased Mr. Preece is in favour of having no switches on the lamps. This removes a source of much cost and trouble. He proposes to switch the lamps on at three different points. I can assure the people of Wimbledon that the effect of lighting the electric incandescent public lamps in this way will be exceedingly pretty. I have adopted a somewhat similar system at Hanley, but we light the whole of the lamps from the works. Very recently we have lighted up about half a mile of straight road, and the effect of all the lamps lighting together is very pretty. It is very different from arc lamps, examples of which can be seen in Tottenham Court Road. Arc lamps do not light up all at once, but flicker and hesitate for some seconds before attaining their full brilliance, whereas incandescent lamps light up at once. In such a district as Wimbledon you can afford to use 32 c.p. lamps, but in Hanley we have to be content with 16 c.p. and 25 c.p. lamps, and the effect is satisfactory. We charge the same price per lamp as you propose to do in Wimbledon, 3*l.* per lamp per annum, inclusive of maintenance and cleaning, so that it cannot be said that the lighting committee or their adviser are asking too much for a 32-candle lamp. We are using in Hanley the same lanterns as are in use in Brighton. I quite agree with Mr. Preece that to mix arc and glow lamps is detrimental to the effect of the latter, owing to the difference of colour. Mr. Preece is also exceedingly modest in his estimate of 1750*l.* as the probable income from private lighting. It may be so for the first year, but it will soon double or treble that amount. The rateable value of Wimbledon is higher than at Hanley, and we already have four times the amount sold, as indicated by the estimated receipt of 1750*l.* We are now considering the destructor question in Hanley. If we can generate sufficient steam from the destruction of house refuse to cover the day load and after midnight load, we shall consider we have done all we can reasonably expect. It is, I think, out of the question to expect to be able to use the destructors for the evening load without the use of coal. I have much pleasure in moving a vote of thanks to the Authors of the two papers.

Mr. J. Barber: I have very much pleasure in seconding that.

Mr. Weaver: What is the rate in the £?

Mr. Cooper: The rate in the £ has been for several years back 3*s.* 2*d.* per annum. I do not think there is a chance of its going up for the present at any rate.

The vote of thanks to the Authors of the papers was then accorded unanimously.

Light refreshment having been provided in the Committee room, the Members proceeded in brakes to Queen's Road, where they inspected the Council's depôt and stables. The buildings were in course of erection at the time, but had proceeded to an extent which enabled the Members to obtain a good idea of the accommodation which will be available. From the Depôt the Members went on to Clarence Road, for the express purpose of viewing the system of *drainage adopted for terrace houses in Wimbledon and the method of drain testing. The inspection concluded, the Members returned in brakes to the Drill Hall, St. George's Road, where luncheon was provided by the hospitality of Messrs. C. H. Cooper; W. Santo Crimp and Arthur Preece; Mr. Lobley presided.*

After luncheon the Members re-entered the brakes and drove to Wimbledon Hall, for the purpose of viewing the improvements effected there, and described in Mr. Cooper's paper. Thence, by way of the Fire Station, the party drove to Lancaster Road, where opportunity was given of inspecting a house in course of erection fitted with the insulating conduit for electric wiring. The system is fully described in Mr. Bathurst's paper. At Cæsar's Camp, on Wimbledon Common, an automatic flushing tank and a Field's syphon were inspected. The next visit was to the Sewage Farm, which has been previously visited by the Association, and described by Mr. Santo Crimp in a paper read at the Meeting. At the Farm, the High Level Tanks, the Cultivation and Storm Water Filters and other works were inspected with close and sustained interest. A very full day's programme concluded with a visit to the works of the Conduit and Insulation Company, where Mr. S. H. Bathurst, M. Inst. C.E., and other Members of the Directorate and Staff, showed their visitors over the works and explained the various points of interest in connection with the insulation process.

Mr. Bathurst then read his paper on "Electric Wiring Practice," the interest of which was enhanced by a number of experiments referred to in the paper.

At the conclusion of the paper a hearty vote of thanks was accorded to Mr. Bathurst by general acclamation.

DISTRICT MEETING AT PATELEY BRIDGE.

June 4, 1898.

C. H. Lowe, M. Inst. C.E., Vice-President, *in the Chair.*

The Members were received at Pateley Bridge Station by Alderman Houldsworth, Chairman of the Bradford Waterworks Committee, and Mr. Jas. Watson, the Waterworks Engineer.

The Minutes of the Ripon Meeting having been read, Mr. Stainthorpe was unanimously re-elected Honorary Secretary for the Yorkshire District.

THE NIDD VALLEY SCHEME.

The Nidd Valley scheme is not merely an extension of the present water supply, it is practically a new and independent scheme, and has many features in common with the great schemes either completed or in progress in connection with the water supplies of Manchester, Liverpool, Birmingham and Glasgow. It means in effect the utilisation, at a cost of close upon 1,500,000*l.*, of the splendid gathering grounds to the south-east of Little Whernside. The necessary Parliamentary powers were obtained in 1891–92, and the work is now well advanced. There will be three storage reservoirs, extending for about three miles along the upper part of the river Nidd, some miles above Middlesmoor.

Storage Reservoirs and Drainage Areas.

The Angram reservoir is situated at an altitude of 1187·50 feet above Ordnance datum, having an area of 69¾ acres, an available depth of 112 feet, and a capacity of 810,000,000 gallons;

Lodge reservoir, at an altitude of 1098 feet, has a top-water area of 84¾ acres, available depth 104 feet, and a capacity of 1,088,000,000 gallons; and lastly, High Woodale reservoir, at an altitude of 994 feet, has a top-water area of 72½ acres and an available depth of 61 feet, and capacity 698,000,000 gallons. It will thus be seen that there is a total storage capacity of 2,596,000,000 gallons, and the united drainage area to the three reserviors is 6800 acres.

In addition to the drainage to the reservoirs there is a drainage area of 11,400 acres, which drains to and is intercepted by the main aqueduct, into which the waters of the following streams are taken: Ruscoe beck, by 616 yards of 12-inch diameter pipes; How Stone beck, by 900 yards of 24-inch diameter pipes; Blayshaw Gill beck, by 217 yards of 18-inch diameter pipes; Ramsgill beck, by 1328 yards of 24-inch diameter pipes; by Colthouse beck and a number of smaller streams direct into the aqueduct.

THE AQUEDUCT.

The main aqueduct is 32 miles in length, and consists of 11½ miles of aqueduct 5 feet 6 inches wide by 6 feet 3 inches high in cut and cover, constructed in concrete; 6⅛ miles of tunnel lined with concrete, this section being also 5 feet 6 inches by 6 feet 3 inches inside; and about 14⅜ miles of cast-iron and steel pipes of 36 inches diameter, of which 5281 yards, or 3 miles, are steel pipes, weighing 1800 tons, and the remaining 11⅜ miles cast-iron, weighing 13,000 tons.

At a point 16 miles distant from its commencement, the main aqueduct is joined by a branch pipe of 30 inches diameter and 2¾ miles in length, from which water can be drawn from the Upper Barden reservoir and the Chellow Heights reservoir in Bradford, or by which Nidd water can be sent into Lower Barden reservoir. At a distance of 18½ miles from its commencement, a pipe of 18 inches diameter, 310 yards long, is taken to Chelker reservoir, and at a distance of 2½ miles the Doubler stones branch, of 6 inches diameter and 2136 yards long, is joined to the main aqueduct. The total length of branch aqueducts is about 6 miles.

The main aqueduct delivers into two reservoirs at Chellow Heights, at an altitude of 845 feet, having a capacity of 64,000,000 gallons. Five filter-beds are to be constructed at each of these reservoirs for filtering the water before delivery into the city. In the construction of the works seventeen bridges have been erected for carrying pipes and aqueducts over valleys, rivers and canals. There are five intake dams, constructed of masonry, for damming back streams which are brought into the main aqueduct by the branch aqueducts mentioned. In each of these are placed separating weirs, and the upper end of each syphon is controlled by automatic valve apparatus to stop the flow in case of accident.

GOUTHWAITE COMPENSATION RESERVOIR.

The Gouthwaite compensation reservoir, now in course of construction, was the first section of the works to which the attention of the visitors was directed on Saturday. On approaching the spot, the dam, now well towards completion, at once arrests the eye by its massive proportions and the features embodied in its design. Long before reaching it the solid wall of masonry can be seen stretching across the valley, the appearance of which will, of course, be largely modified when the reservoir is completed and filled with water. Pasture land and wooded slopes, through which now runs the Nidd, being submerged by the formation of a lake some 2 miles. The reservoir, the site of which is about 2½ miles above Pateley Bridge, will have a top-water level of centre bays 446 feet above Ordnance datum and of side bays 447 feet above Ordnance datum, a depth at the dam-face of 42 feet, and a storage capacity up to 446 feet above Ordnance datum of 1,564,000,000 gallons. The dam is constructed of cyclopean rubble in cement, the maximum depth from foundation to top-water level being 105 feet and the thickness at the base being 70 feet. On the up-stream side the wall has a batter of 1 in 16, with a curved batter on the down-stream side, the face and back of the dam being formed with large square pitch-faced blocks of hard grit stone. The overflow is carried over the crest of the dam through fourteen arches, each of 31 feet 6 inches span. Upon these arches a carriage road is formed 10 feet in width, the parapets of the road being of pierced and moulded ashlar.

Two culverts, each 10 feet in diameter, are constructed through the wall of the dam, and are controlled by valves and outlet pipes fitted up in two valve towers of masonry, lined with cast iron, erected on the inner side of the dam. The drainage area to this reservoir is 9900 acres, which is set apart as a compensation area for supply to those having mills, riparian or other interests in the stream below. The public road on the western side of the reservoir has been diverted for a length of 3050 yards, and the occupation road on the eastern side for a length of 983 yards. The quantity of masonry and concrete in the dam is about 70,000 cubic yards. The aqueduct and tunnel will carry 27,000,000 gallons per day, but one line of 36-inch diameter pipe, which is only now being laid, will carry 10,000,000 gallons per day. The estimated cost of the entire works is 1,370,000*l.*

The contractors for the aqueduct and tunnel works are Messrs. Morrison and Mason, Glasgow; for the Gouthwaite reservoir works, Mr. John Best, Edinburgh; for cast-iron pipes, Messrs. Cochrane, Grove and Co., Middlesbrough; for steel pipes, Messrs. Thomas Piggott and Co., Birmingham; for service reservoir, filter-beds, &c., Mr. Phineas Drake, Bradford; and for valves and other ironwork and appliances, the Glenfield Company, Kilmarnock.

At the outset the Members were taken to the quarry on the area of the works from which the stone is being quarried for the dam. The dam of the Gouthwaite Compensation Reservoir was then inspected from the bottom of the reservoir, and then, ascending to the higher level, the carriage road, which has had to be constructed in connection with the scheme, was visited. From the Gouthwaite Compensation Reservoir the Members drove to How Stone beck, the drive being full of interest, through a country abounding in picturesque beauty. The drive afforded a splendid opportunity of gauging the extent of the compensation reservoir. A halt was made at the point where the river disappears, to flow for a distance of some two miles underground, returning again to the light of day at Softhouse. At How Stone beck the Members left the brakes and walked through the wild gorge where the river has fashioned its course through the rocky slopes of Whernside. After a short delay, to shelter from a heavy shower, the Members walked across the rough moorland, past Softhouse and Middlesmoor, to the contractor's railway, which follows the lines of conduit southward, for the purpose of inspecting the intercepting weirs, syphon, valve-house and other matters of engineering interest in connection with *the scheme. The train had only traversed a short section of the journey when a tragic incident occurred which threw a distressful gloom over the remainder of the day's proceedings. Mr. William Tuley, Surveyor to the Urban District Council of Rothwell, near Leeds, was seized with an attack of heart weakness, and though every assistance possible was rendered to the unfortunate gentleman, he succumbed to the attack before medical aid could be procured. In these sad and distressing circumstances the remaining portion of the day's programme was reduced to the narrowest possible limits. The train was run to the point where the brakes were in waiting, and the Members returned to Pateley Bridge.*

On arrival at Pateley Bridge the Members were entertained to dinner by the Bradford Waterworks Committee.

DISTRICT MEETING AT NORWICH.

June 10, 1898.

Held at the Guildhall, Norwich.

J. T. EAYRS, M. INST. C.E., PAST PRESIDENT, *in the Chair.*

THE Members were received by the Mayor of Norwich (Mr. C. C. Rix Spellman), who offered a very warm welcome to the Association.

Mr. Eayrs thanked the Mayor for his kind welcome, and the following paper was read.

SOME MUNICIPAL WORKS IN NORWICH.

BY ARTHUR E. COLLINS, ASSOC. M. INST. C.E.,
CITY ENGINEER, NORWICH.

IN consequence of difficulties arising out of the train services from London and from Peterborough, it has only been practicable to arrange for a very short meeting of our Association in Norwich, consequently this paper will not deal exhaustively with the Public Works of Norwich. It has been written to show the reasons for, and to facilitate the comprehension of some of the works to be visited by you this afternoon.

The population of Norwich in 1821 was 50,288.
„ „ „ 1881 „ 87,842.
„ „ „ 1891 „ 100,970.
Estimated June 1898, 112,000.]
Average annual death rate for past five years, 18·59.

It comprises the City and the County of the City of Norwich, its boundaries being defined in the Charter of Philip and Mary. The area is 7472 acres. The rateable value is 346,553*l.*, which is excessively low having regard to population and area; as a result the rates in the £ are high. Some portions of the drainage system still in use are centuries old. During the past few years considerable lengths of large ancient sewers have been put out of use. Generally they were built with walls and flat bottoms constructed of flints in lime mortar, and covered with brick arches. Some fifty years since extensive sewerage works were constructed, the sewers then constructed discharging into the river, with the result that the river got exceedingly foul. A main outfall sewer with branches was constructed some thirty years since, to intercept the old sewers and deliver the sewage to a main outfall sewage pumping station constructed at the same time at Trowse. From this point the sewage is pumped on to a sewage farm having a total area of 503 acres, 268 of which are available to receive sewage. The land is irrigated with raw sewage, no precipitation, filtration or other process being used. The farm is satisfactorily let. When the main outfall sewer was brought into use thirty years since, it was found to be so leaky as to make it practically impossible for the three powerful beam pumping engines at the outfall to keep the sewer pumped down. This state of things was due to the following facts.

1. In consequence of the extent of low-lying inhabited area to be dealt with, the main outfall sewer, having to deliver outside the city, had to be kept very low through most of its length. At its outfall the invert is 19 feet below the line of saturation; it continues below this line for about 2¼ miles.

2. The soil along most of the line of sewer is so freely pervious to water, that it may almost be described as an underground lake. The line of saturation being practically river level, drainage of the subsoil except by pumping is impracticable.

3. Whilst the brickwork of the sewer, wherever the Author has examined it, is good, it is not water-tight. In his opinion it was scarcely practicable to make it water-tight under the conditions. Had iron construction been adopted at that time the new scheme now in progress would not have been required excepting as regards the newer parts of the city.

The Corporation, finding the state of things here named to exist, consulted the best engineering talent of that day, with the result that the most leaky portions of the sewer were lined with iron. Whilst the lining itself was water-tight, the total amount of leakage was not materially decreased by it, as when the water was dammed out at one place it found its way in at others, more especially at the junctions of iron linings with the unlined brickwork, and whilst many devices were tried to overcome this, none were successful. As the ultimate result the then City Engineer (Mr. P. P. Marshall, who took office after these difficulties had arisen) advised—

1. The construction of a new main outfall sewer at a higher level than the old one, and the abandonment of the old one.

2. The adoption of the Shone system for raising the sewage of the low-level districts into the new main outfall sewer.

3. The re-drainage of the whole of the city on the separate system. The undertaking contemplated being of a very extensive character, the Corporation obtained its Act of 1888, giving them powers to do the necessary works, including the construction of air mains beneath the streets, and borrowing powers to the extent of 80,000*l.* The works were then put in hand under Mr. Marshall's direction, and carried on by him until his resignation of office; they were continued by the late Mr. Buchan until his resignation, and since by the Author. Throughout, Messrs. Shone and Ault have been the consulting engineers as regards the ejectors, air and sealed mains and air compressors, which have cost about 25,000*l.* out of a total expenditure which at completion will reach about 164,000*l.* Until about two and a half years since the works were carried on by men in the direct employ of the Corporation; since then contracting has been resorted to, excepting in the cases of certain difficult works where the amounts contractors would of necessity have to charge, to cover risks, would be large. In these cases the works have been done by the Corporation staff. The Corporation has been very fortunate in securing the services of most competent contractors, they being Messrs. Hughes and Lancaster, of Westminster, for the ejector stations, air and sealed mains and air-compressing machinery; Messrs. Monk and Newell, of Liverpool, for the sewers in the western low-level district; and Messrs. B. Cooke and Co., of London, for one high-level and four low-level districts.

The new main outfall sewer is constructed of circular concrete pipes surrounded with cement concrete, commencing with an internal diameter of 3 feet 6 inches. At the outfall its invert is 5 feet below the line of saturation. Otherwise, excepting in the case of pipes across the river, the whole of the sewage sewers are constructed of circular stoneware pipes, which are jointed on Parker and Hassall's system beneath or near the line of saturation, and in all places where special care is required. This joint was adopted after trials of various systems of joints, including one devised by the Author at the suggestion of Mr. Ault. The trials consisted of laying lengths of sewer from manhole to manhole in the most waterlogged ground available, and noting the leakage (if any) both before and after the trenches were filled up. The results obtained in laying long lengths of Parker and Hassall's pipes in waterlogged ground, have, in the Author's opinion, quite justified his choice. The air mains are almost throughout of cast-iron, socketed, lead-jointed pipes. Here attention must be drawn to the necessity for the greatest possible care to ensure air-tightness. Leaks are easily located before the pipes are covered, by filling the pipes with air under pressure, and painting all the joints, &c., with soapy water, when the most minute leaks will reveal themselves by the formation of bubbles.

The sealed mains consist in almost all cases of cast-iron, socketed, lead-jointed pipes. They are for the purpose of conveying sewage from the high levels on one side of the valley through which the river runs to the new outfall sewer on the other side of the valley; they also receive the pumpage from the ejectors. Each of these sealed mains forms an inverted syphon, dipping, in the case of the 24-inch pipe crossing the Wensum at Fye Bridge, to the extent of 16·75 feet below the hydraulic gradient, and, in the case of the 12-inch pipe at Carrow Bridge, 14 feet below the hydraulic gradient.

To ensure cleansing velocities through these deeply inverted syphons, almost the whole of the sewage passing through them is delivered in concentrated flushes—that from the high levels by the aid of automatic flush tanks, that from the low levels by the ejectors. Two of these inverted syphons have been at work for several months without any trouble arising, except as regards the sufficient ventilation of the pipes between the water level when not discharging and the flush tank or ejector inlets. What he considered sufficient ventilation was provided by the Author, but he had to materially increase it before obtaining sufficient velocity of discharge from the automatic flush tank or ejector as the case may be.

For the construction of the sewers across the river at five points, comprising nine actual pipe crossings, various methods were adopted as circumstances dictated. At Carrow Bridge, where the river is crossed by a 12-inch sealed main, a 7-inch low-level gravitating sewer and a 3-inch air main, advantage was taken of the old low-level branch sewer 30-inches in diameter to receive the three new pipes. The old sewer was too small to admit of the joining of pipes within it; moreover it was neither straight, horizontally nor vertically. The work was done as follows. A trench about 12 feet long was sunk down to the old sewer on one bank of the river, and a working shaft about 7 feet square on the other bank, and the arch of the sewer removed at each end. The pipes were lowered into the trench and jointed at the bottom. The whole of the pipes were steel, lap welded; the joints of the 12-inch and 7-inch pipes were spherical, the sockets being of steel bored to spherical shape, the male ends were faced, turned to a narrow chamfer at the extreme end and provided with three grooves, to hold the jointing lead. Two pipes having been put in position for jointing and tightly forced together with a screw jack, the joint was run with lead and caulked tightly between the outside of the cylindrical male end and the inside of the spherical socket. The joints of the 3-inch steel air main used at this point were made with ordinary screwed sockets, with back nuts and gaskets at the end of each socket to ensure air tightness. The joints having been made on a section, and the pipes bundled together in fagot fashion, they were drawn into the old 30-inch iron sewer beneath the river by means of a chain attached to the shoreward end of the pipes, passing from thence through the 30-inch pipe to a crab fixed at the bottom of the working shaft at the opposite side of the river. The bundle pipes having been drawn a pipe length into the old 30-inch pipe, the cycle of operations was repeated until the three pipe lines were completely laid across the river. After this the pipes were tested, when it was found that, notwithstanding the fact that at one half of the joints flexure had occurred in at least three directions after the joints had been made, and that at all the joints some flexure had taken place, all of the joints were quite free from leakage and the pipes throughout water or air-tight as the case might be. At times the force required to move the pipes was so great that a hydraulic jack was required to push whilst the crab pulled. At Foundry Bridge advantage was taken of the existence of the old low-level sewer crossing, which consisted of an iron pipe of 6 feet internal diameter. The size available made constructional work comparatively straightforward at this point.

At Fye Bridge a 24-inch sealed main inclining from north to south, and a 9-inch gravitating sewage sewer from south to north, had to be constructed beneath the bridge and below the navigation depth of the river. This work had to be done without stopping the bridge for traffic or the river for navigation, excepting during a limited number of hours, and was effected as follows. Steel pipes 30 feet long (the span of the bridge being 33 feet) were obtained; at both ends of this pair of pipes wooden yoke pieces were attached in such a manner as to secure the pipes in their proper relative positions to each other; the joints between the yoke pieces and the pipes were caulked so as to be watertight, the sides of the yokes were grooved to receive the sheeting planks of a coffer dam, and to their tops doors were hinged; such doors afterwards formed parts of the coffer dams. The pipes having been prepared in this manner, they were floated upon a pontoon beneath the bridge and slung from the bridge, by means of proper tackle, above a trench which had previously been dredged to receive them. The pontoon was then floated away and the pipes lowered on to the dredged bed. Up to this time the doors above mentioned were lying horizontally upon the pipes, this being necessitated by the limited head-room beneath the bridge. When the pipes had been lowered the doors were raised to the vertical position, the position of the pipes accurately adjusted by the aid of marks previously placed upon the doors, and the pipes covered with concrete. Coffer dams were then driven in continuation of the small portions of such dams formed by the doors and yokes. The driving of the piles had to be effected to a great extent by means of hydraulic jacks which abutted against the under side of the bridge. Shafts were then sunk at the landward end of both abutments, and headings driven beneath the abutments into the coffer dams. This work had to be carried out at such a depth as to be in parts below the points of the piles supporting the bridge abutments. A manhole was built at each end of the river length; through these manholes the pipes are carried in special castings provided with large access doors to enable blockages to be dealt with should they occur. Blow-outs and stop-valves are also arranged on the up-stream side of each of the deepest dips, to enable the pipes to be to a great extent emptied without pumping. These precautions were taken with the whole of the inverted syphons excepting that from No. 5 ejector near New Mills, where the dip is comparatively slight. Along many miles of route both surface water and sewage sewers have had to be provided, the old combined sewers being, from one cause or another, unsuitable for retention as surface water sewers. Through nearly the whole of this length the sewage sewers are required to be much deeper than the surface water sewers; the former are invariably constructed of pipes, and the latter partly of pipes, but to a great extent of brickwork in cement. In all cases the trenches are excavated in such a way as to accommodate both sewers in one trench, the trenches being got out wide enough for both sewers to the necessary depths; for the shallower sewer a benching is then left, and a narrower trench carried down for the deeper sewer. In consequence of the nature of the soil and the precautions taken, no disturbance or settlement of either of the shallow sewers has been noticed excepting in one short length, notwithstanding the fact that the deep trench is not refilled with concrete, but only with selected excavated material. The special precautions taken have been to select the most suitable excavated material for refilling purposes, to have it well rammed, and where the work is beneath the line of saturation (as it mostly is) to allow the water to rise before commencing to lay the shallower sewer. Where the work is being carried out above the line of saturation a plentiful supply of water is used to assist consolidation. It was in consequence of a neglect of this precaution that the only disturbance of one of the shallower sewers above referred to occurred. The difficulties arising from the attempt to carry out the separate system in this ancient and irregularly built city were found to be so great, and likely to lead to such an enormous outlay, that the Author soon after his appointment advised that, excepting in the low-level districts drained by means of ejectors and in new buildings and new building estates, the separate system be not proceeded with for the time being, but that the then existing combined sewers be intercepted at suitable points in such a manner that sewage and storm water up to a sufficient dilution should pass into the sewage sewerage system, and after the pre-arranged amount of dilution had been exceeded, the whole flow should pass to the river, which, where any of the storm overflows exist, is tidal, and below the New Mills weir, which in its turn is some distance below any water-works intake. The Council accepted this proposition, and since that time the works have proceeded on the lines recommended. Whilst the Author upholds the separate system of sewerage as the best one extant, yet the complications and expenses are so great in cases similar to that he is dealing with in Norwich, that he feels he is perfectly justified in the departure from it he has made. At New Mills a working model will be exhibited of a valve used for effecting the required storm water separation.

EJECTORS.

For the drainage of the districts lying below the levels commanded by the new main outfall sewer, six ejector stations have been constructed, each containing a pair of Shone's ejectors, manufactured by Messrs. Hughes and Lancaster. The pair of ejectors at station No. 5, near New Mills, are the largest yet constructed, and are notable as having double inlet and outlet pipes and valves to facilitate filling and discharging. This pair of ejectors have lifted 1500 gallons per minute against a head of 14 feet 8 inches, through an 18-inch rising main 375 yards long, discharging into the main outfall sewer in St. Benedict's Street. The whole of the ejector stations are for the greater part of their depths below the line of saturation; large volumes of water had to be dealt with in sinking them; in two cases pumping was of no avail, and air pressure had to be used during the excavations.

Air, under a nominal pressure of 15 lbs. to the inch, is distributed to the six ejector stations from the power station at New Mills through 2⅜ miles of cast-iron pipes, having a maximum diameter of 9 inches and a minimum of 3 inches. As the pipes were laid, and again after completion, they were tested with air pressure at 40 lbs. to the inch, and were not accepted unless the losses from all causes amounted to less than 5 per cent. of the absolute initial test pressure in one hour. The installation completely satisfied this condition; if it had not done so, the contractors would have been required to apply a hydraulic test of 40 lbs. to the inch to the pipes, and localise leaks by the aid of Guest and Chrime's waste-water detector. This, however, was not necessary in Norwich.

The air compressing machinery consists of two pairs of horizontal compound non-condensing steam engines, having cylinders 9½ inches and 14½ inches by 18 inches stroke, actuating 15 inches by 18 inches stroke air compressors, the valves of which are double lipped. The inlet valves are mounted on the piston rods in such a manner as to have a positive motion in assistance of that due to difference of air pressure on their opposite sides; the delivery valves are independent, and are opened and closed by the variations of air pressure on opposite sides. The initial steam pressure is 120 lbs. on the square inch; steam will be supplied when required from a Babcock-Wilcox water-tube boiler, heated by the products of combustion from two Horsfall refuse furnaces, which have been constructed within an old building already provided with a chimney 100 feet high, and situated about 40 yards from the power-house, and on the opposite side of an arm of the river. Steam is conveyed to the engines through a 5-inch steel pipe, which, where outside, is covered with Leroy's non-conducting composition 3 inches thick, protected from the weather with galvanised iron sheeting. Whilst steam has not been required for driving the air compressors up to the present, the alternative power to be hereafter described having been sufficient, tests of the furnaces and boilers have been made, when it has been found that the two furnaces, each having a grate bar area of 5 feet 6 inches by 5 feet, are capable of burning about 90 cubic yards or 30 tons of refuse per twenty-four hours, and of evaporating water at the rate of 2400 lbs. per hour, at a pressure of 125 lbs. The method adopted for raising the refuse is special, and was due to the fact that sufficient space was not available for the construction of an inclined road to the top of furnace setting, which is higher than usual above ground level because of the liability of the site to floods, and the desire to keep the flues, &c., dry.

The method in question is as follows. A sunk rail pit has been constructed in such a manner as to enable the house scavenging vans to tip their contents into trucks running on rails in the rail pit. The trucks are each of equal capacity to that of a van. When refuse is required for the furnaces, an overhead rope-driven traveller, which commands the rail pit and the furnace top, raises the body only of a truck, travels with it to the charging hole of a furnace, where the truck bottom is opened and the refuse is deposited; the empty truck is then returned by the traveller to its wheels. A sufficient length of rails has been provided to accommodate twelve trucks, and storage for additional truck bodies is being provided at the level of the furnace top. The six trucks included in the experimental delivery do not give quite satisfactory results, as, in consequence of the local practice of collecting every class of refuse, a large amount of fibrous material, such as straw, &c., has to be dealt with which does not fall through the openings in the truck bottoms freely. It is intended to adopt a different arrangement for the remainder of the trucks and to alter the six experimental ones. The new trucks will be provided with trunnions to enable them to be tipped and thus emptied.

The flow of the River Wensum, which has an average fall of 6 feet 6 inches at New Mill, offers an alternative to the steam plant for actuating the air compressors. The water is used through two 48-inch "Victor" turbines, supplied by Mr. F. Nell, of Queen Victoria Street, London; their construction will be explained at New Mills by the aid of a model of the wheels, where also a model ejector has been fixed.

Each turbine drives one of the engine crank shafts through a pair of bevel wheels. Whilst the turbines are doing the driving, the piston rods of the engines are uncoupled between the steam and air cylinders and the eccentric rods disconnected. When the engines are driving, the turbines are uncoupled from the crank shafts.

The old-fashioned small sluices which formerly existed at New Mills caused river floods to be greater than they should have been, due to a great extent to the tendency they had to become blocked with débris brought down by the river. In constructing the new works advantage has been taken of the late Mr. Stoney's invention, and a sluice on his principle, 14 feet 3 inches wide by 8 feet deep, has been provided. This sluice was supplied by Messrs. Ransomes and Rapier, of Ipswich; it can be raised or lowered with the full head of water against it, by one man.

The Corporation contemplate removing some cottages adjoining New Mills, and using the whole site available for the purposes of stores, stables and workshops, with a railway siding running into it from the Midland and Great Northern Joint Railway.

ENGINES AT TROWSE MAIN OUTFALL.

In consequence of the new outfall sewer delivering at a level of 14 feet above that of the old one, and of the desire to take advantage of this for reducing the pumping head with the least possible capital expenditure, the Author designed modifications to the existing pumps of a very small and simple character, which enable the advantages aimed at to be obtained. These alterations consist of the coupling of the suction side of each pump direct to the new outfall penstock and screening chamber, in such a way as to render the pumps self charging: that is to say, instead of its being necessary to create a partial vacuum in the pump barrel before the sewage will flow into it, the sewage will flow into the pump to a height of about 8 feet 6 inches above the inlet (formerly suction) valve by gravity alone, provided air is not imprisoned in the pump.

The only alteration to the pumps themselves consisted in increasing the weights of the inlet valve to such an extent as to ensure perfect closing immediately the bucket and ram commence their down-stroke. If the valves are too light, water is slipped and hammering takes place; if too heavy, energy is wasted. A distinct sanitary advantage as regards the engine-house staff arises from the alteration. Under the old arrangement the whole of the basement of the engine house formed a reservoir for the reception of sewage, the stench from which has often been almost unbearable; the new arrangement when completed will obviate this.

In the screening chamber, screens with self-acting cleaning rakes, and rotating rakes to clean the cleaning rakes, have been constructed by Messrs. Stott and Co., of Haslingden, who constructed almost identical apparatus from the Author's design in 1882. In the same chamber is a hand-wrought silt dredger, which travels on rails parallel with and in front of the screen; it dredges from a small silt pit constructed in front of the foot of screen. The two sets of apparatus work quite satisfactorily, unless a plank of wood or similar obstruction finds its way into the sewer and happens to get between one of the pitch chains and its wheel, in which case, where the screen rakes are in question, usually the leather driving belt slips off its pulley, but now and again a chain or some other part of the gear breaks. The Author is quite aware of the fact that large pieces of wood and such like things should not be permitted to pass into a sewer; unfortunately in Norwich such articles do at times find their way into the sewers, and up to the present the sources from which they come have not been discovered.

The screening chamber is constructed of cement concrete; it is 27 feet deep by 23 feet by 17 feet 6 inches, and is divided into two screening compartments. The foundations are carried about 16 feet below the line of saturation.

The method of construction adopted was as follows. An excavation, somewhat larger than the length and breadth of the chamber outside walls, was sunk to a depth of 6 feet, at the bottom of which a cast-iron curb, provided with a cutting edge, and enclosing a rectangle of the length and breadth of chamber outside walls, was fixed. Four rough trusses were then constructed, resting upon the ground at ordinary ground level, and spanning the excavated area at distances apart of about 5 feet. From these trusses concrete moulding boards were slung in the proper positions to support both sides of the concrete of walls whilst setting. Concrete was then filled in upon the cast-iron curb, and between the moulding boards, to a depth of 6 feet. When this had set, the wedges holding the concrete moulding boards up to their work were slacked, and the boards swung just clear of the concrete; the ground within the site of chamber and its walls was excavated for a further depth of 6 feet. This excavation was done regularly all round, and as it proceeded, the cast-iron curb, with its superincumbent load of concrete walls, settled down. When the settlement amounted to 6 feet, the moulding boards were again wedged into position, and a further depth of 6 feet of concrete filled in upon them, and so on until the full depth of 27 feet had been reached. A V-groove was roughly formed along the top of each concrete section, to ensure good jointing between the sections. The full depth having been obtained, the ground below the site of chamber bottom was covered with rough flints, below which were laid drain pipes to convey the large volumes of water met with into the sump. Upon these flints roofing felt was laid, to prevent injury to the concrete bottom of chamber, which was formed upon this roofing felt. As was expected with such a large practically monolithic mass of concrete, cracks showed here and there, but none of them were of any consequence. The chamber is water-tight. Holes to receive the inlets from main outfall sewer, suctions, pipes of pumps, wall boxes for screen-cleaning gear, &c., were cored in the concrete by means of wooden cores.

In addition to the sewerage works, now approaching completion, the Norwich Corporation have carried out a variety of other works during the Author's tenure of office, two of these only, being somewhat special, will be referred to. The stonework of the exterior of the Free Library (which, by the way, is one of the oldest buildings in the country erected under the Free Libraries Act) had become much defaced by decay—so much so, in fact, that the mouldings, &c., were to a great extent unrecognisable. The cost of restoring the work in stone was found to be so great that a contract was entered into with Messrs. A. Dreyfus and Co., 15 Featherstone Street, City Road, E.C., to cut away the whole of the decayed portions of the stonework, and to make good the whole of the work to the original features with Tabary's Patent Metallic Stone Cement or Imperishable Artificial Stone. This work was done by French workmen, the contractor having, he informed the Author, failed in his attempts to get English workmen to learn the necessary operations. At the same time such of the old stonework as had not crumbled away was coated with Szerelmey Stone Liquid. Notwithstanding that the work has been subjected to some sharp, if short, frosts since then, no defect of any sort has shown itself, whereas previously scarcely a week passed without flakes or larger pieces of stone falling from the building.

Adjoining the Free Library is the former Palace of the Dukes of Norfolk, used in recent years as a Museum, and now converted, as to a portion, into public slipper and stand-up wash baths, and, as to the remainder, into offices, &c., for the Guardians. The stand-up wash baths have been adopted with the view of enabling the Corporation to give a warm bath with cold shower for one penny. The arrangement of the stand-up baths is as follows. Cubicles, with wooden divisions enclosing spaces of 5 feet 9 inches by 4 feet, are constructed; in the concrete floor of each of these a glazed foot-bath is placed, the top of foot-bath being flush with the surface of floor; in front of the foot-bath, and at a suitable height above its bottom, a glazed lavatory basin is fixed with hot and cold supplies. The foot-bath is filled through the basin. Above the foot-bath is a glazed waste preventer tank, depending from which is a double rose shower.

The whole installation has been made with the object of getting an efficient and reasonably-comfortable bathing establishment, for the use of persons whose houses do not contain baths, at the lowest practicable capital cost. The whole cost of adapting the old buildings, which necessitated lowering basement, covering two open yards, one of which now contains the ticket office, entrance corridor, towel store and water-closet, and the other the second class slipper baths, and including the whole of the engineering, will not much exceed 1900*l.*

A Technical Institute is now being built near St. Andrew's Hall; the total cost is estimated at 22,000*l.* The contract for the buildings has recently been let to Mr. Samuel Warburton, of Manchester.

DISCUSSION.

The **Chairman**: There do not appear to be any important questions to be asked just now, and probably the Members would like to see the works before asking Mr. Collins any particulars as to the details. I have therefore much pleasure in proposing a vote of thanks to Mr. Collins for his paper. I am sure it contains a great deal of matter which is very interesting and novel, particularly some of the methods which he has employed for dealing with underground water; and other points are worthy of very great consideration, striking out as they do new lines for some of the Members. Happily, we are not all of us situated as Norwich is with respect to underground water, but nevertheless the paper is a revelation of the difficulties which have had to be met and overcome.

Mr. E. G. **Mawbey**: I do not think I know of any town which presents such difficulties as Norwich. Having in our memories regard for an esteemed colleague in the late Mr. Morant, it is very satisfactory to hear that, although the sewers were so leaky, the brickwork was found to be satisfactory. There is no doubt that Mr. Morant did the best he could under the great difficulties he had to contend with.

The proposition was then put to the meeting, and adopted unanimously.

The **Chairman**: There is another duty we have to perform, that is to accord a vote of thanks to the Mayor and Corporation for so kindly placing the Guildhall at our disposal.

Mr. J. **Price** seconded the vote of thanks, which was accorded unanimously.

CORRESPONDENCE.

Mr. J. **Price**: I should like to know what has been or will be the total expenditure on the sewage system as distinct from the disposal works during the last 25 or 30 years. Has the partial separate system been in use for this period? If not, has there been any clogging of the soil at the sewage farm, as I gather from the paper that no roughing tanks are used for the purpose of eliminating heavy matters such as road detritus. Also, what effect pumping such matters has had in wear and tear on the pumps. Mention is made of the use of leaping weirs in working certain districts on the combined system. In such cases what is the proportion of dilution before the diluted sewage will pass direct to the river, and what volume per head of the population does this represent? This is a matter growing in importance, especially having in view the proposed and more stringent legislation on the pollution of rivers, which is looming in the near future. I have to congratulate the Author upon some of the ingenious methods which he has pursued in overcoming difficulties of a somewhat exceptional nature.

Mr. E. J. **Silcock**: I would be glad if the Author of the paper would state how he made a water-tight joint under the yoke surrounding the pipes at the Fye Bridge sewer crossing. The method adopted for coffer damming appears to be a very ingenious one, but from the description it does not seem quite clear how the water was prevented from coming in from below, as presumably the river bottom would be formed of pervious materials. With regard to the system of constructing the sewage sewers and surface water sewers in one trench, I should have feared that where the latter are constructed of brickwork there would be a danger of the brickwork losing its form owing to the haunches on the deep trench side having only made ground to abut against. It must be somewhat of a disappointment to the advocates of the separate system of sewering to find that the Author (who is looked upon as rather a leader in that line) has advised his Corporation to adopt the system in its entirety only in the low levels and in new estates to be laid out in future, and his action quite confirms my opinion that the separate system is only applicable in very few cases where old towns have to be dealt with.

Turning to the description of the destructor furnaces it appears from the figures given that the destruction of 1 lb. of refuse in the Norwich furnaces will raise 0·85 lb. of steam, and this figure confirms the statement made by the writer in the discussion on Mr. Cockrill's paper that the best results hitherto attained have not exceeded 1 lb. of steam for 1 lb. of refuse. As the average collection of refuse varies from 20 to 30 cwt. per head per annum, this means that if all the refuse is utilised the power available will vary from 13 to 19 horse-power per 1000 population, allowing 20 lbs. of steam per horse-power per hour.

The automatic valve, for diverting the combined rain water and sewage after a pre-determined degree of dilution has been reached, appears a very satisfactory piece of mechanism. It would add to the value of the paper if the Author would state the degree of dilution which he has adopted as a standard. From an inspection of the model of the automatic valve, it appears that there must be a loss of fall between the inlet sewer and the dry-weather sewage outlet. This is of no importance where plenty of fall is available, but cases often occur where this drop is difficult to obtain. Some years ago I designed an automatic overflow valve to meet this difficulty. There is no alteration of level in the invert of the sewage sewer, and this makes the valve especially applicable to existing sewers of flat gradient. The outlet from the chamber marked "Sewage proper outlet" is proportioned so that it will be running full when the sewage is diluted to the desired degree. Any further increase in the volume of rainfall will then back up in the chamber and lift the float box. Directly the float box commences to rise, the damper at the sewage outlet begins to close, and as the diameters of the pulley wheels are in the proportion of 4 to 1, a lift of, say, 3 inches on the box will close the sewage outlet if the latter is 12 inches in diameter. As soon as the storm abates the float box drops, opening the damper, and the sewage resumes its normal course.

The AUTHOR: In answer to Mr. Silcock, the yoke pieces surrounding and coupling both ends of the pair of pipes were of sufficient depth below the pipes to allow for forcing down into the sandy gravel below the pipes; the joints between the yoke pieces and the pipes were caulked with yarn. Each yoke piece, with the timber sheeting below the pipes and the hinged flap above the pipes reaching to above river level, formed, when in position, a section of a dam which was continued each way round the bridge abutments by driving or forcing down 3-inch by 11-inch sheet piling. They were practically water-tight, but a considerable quantity of water came up through the sandy gravel forming the floors of the areas enclosed by the dams; this necessitated the use of steam pumping machinery to enable the works to be proceeded with. As regards the risk of deformation where large brick sewers are constructed in trenches common to two sewers at higher levels than the other sewer, and without using concrete for filling the deeper sewer up to the haunches of the shallower sewer: in most soil the Author thinks the proceeding would be extremely risky in gravel, and with reasonable care the Author has found his method of procedure perfectly satisfactory. Careful examinations after completion of long lengths of double sewers constructed as indicated have failed to discover deformation or other defects due to settlements or consolidation of filling.

The Author designed the automatic intercepting valve, of which a working model was shown in operation at New Mills, to suit the special circumstances of Norwich. He is using one where the available drop between the invert of combined sewer and the intercepting sewer is 7½ inches; if a case arises requiring such treatment he sees no difficulty in making the outlet pipe of valve in such a way as to require no drop between the two sewers, but there would be slight damming up of the flow in combined sewer when valve is closed, i.e. when communication with the intercepting sewer is cut off. The Author was unacquainted with Mr. Silcock's automatic intercepting and storm overflow valve at the time he designed the valve in use at Norwich, otherwise probably he would not have gone out of his way to design a valve. Mr. Silcock's valve seems to be a very good one, it not only cuts off the connection to the intercepting sewer when required, but at the same time removes the dam between the combined sewer and the storm overflow. I think it would be improved and made more certain of action by hanging the sluice in such a way as to eliminate sliding friction as much as possible. This could be done by extending it upwards, and holding and guiding it by means of pivoted radius rods. In answer to the questions of Mr. Price and Mr. Silcock, the degree of dilution fixed by the Author as sufficient in the case of Norwich, where all storm overflows discharge into the tidal part of the Yare, is one in three and a half, or at the rate of 70 gallons per head of population per diem. In answer to Mr. Price, as nearly as the Author can ascertain, the expenditure on sewers since 1870, including outfall pumping station and the works now in progress, at their completion in about nine months' time, will have amounted to about 250,000*l*. This does not include a considerable mileage of sewers constructed at cost of current rates. The partial separate system has not been in use at Norwich in anything approaching a complete manner until quite recently, and even now it is only approaching completion. The soil is as suitable for the reception of sewage now as on the first day of its use. At times if parts are overdosed clogging takes place, but a short period of rest restores the land. The sewage is treated in no way whatever beyond passing it in its raw condition over the land. In Norwich, in consequence of heavy rainfalls, steep gradients, the large use of gravel for street making, the relatively small areas paved, the long mileage of streets without paved channels, and the small number of gullies, a very large amount of gravel, &c., finds its way into the sewers, from which most of it has to be removed; a portion finds its way to the outfall, where most of the remainder is removed by means of the silt-pit dredger constructed two years since. The working parts of the bucket and plunger pumps used to be deeply scored and the valves defaced by the grit, but the introduction of the silt-pit and its dredger and the use of special packings have reduced this wear considerably. The Author prefers leap weirs to any system of valves, &c., for separating largely diluted sewage from sewage; he is of opinion that, in addition to their simplicity, they cause heavy silt brought down by rainstorms to find its way to the storm overflows, and not to the sewage intercepting sewers: this is a point provided for also in his automatic valve, which he only uses where sufficient fall is not available to the storm overflow sewer to admit of a leap weir.

In answer to questions put to the Author at New Mills respecting the use of silicate of soda to hasten the setting of Portland cement, the method of use is as follows.

The silicate of soda is bought in solution; this solution is mixed with water until the specific gravity becomes 1·050, for which purpose one of Twaddell's hydrometers is used. If it is desired to make the surface of ordinary cement work set quickly so as to prevent the rush of water from disturbing it, ten minutes to a quarter of an hour after the cement joint has been made, or the plastering applied, as the case may be, its surface is painted with the solution of silicate of soda. This enables the body of the cement to set in the ordinary way whilst the surface is protected. If it is wished that the whole body set quickly, gauge the cement with water mixed with solution of silicate of soda until the specific gravity above named (1·050) has been reached, instead of plain water. In this case the cement sets very rapidly, and can only be mixed in very small quantities.

The Author has used this solution for mixing concrete where circumstances have required it to be deposited in situations subject to flows of water. It may be used for stopping leaks in brickwork by mixing the cement with finely cut cotton waste and then gauging with the silicate of soda solution instead of water; in this case there must be more silicate of soda present. If too much is used the cement sets so very quickly as to leave no time to use it. The silicate of soda as bought by the Author is of the consistency of very thick treacle, and requires a considerable quantity of water added to reduce to 1·050 specific gravity.

The Members proceeded from the Guildhall in brakes on a round of visits of varied interest. The first stop was at St. Andrew's Hall, one of the most historic buildings in the city, where opportunity was given of seeing the work of a pneumatic painting machine. The work of this ingeniously contrived machine was followed with much interest, and substantial evidence was given that the paint can be laid on expeditiously and with evenness, as thickly or thinly as may be required. The next visit was to the New Mills Air-compressing Station. This station is provided with two Victor turbines driven by a fall in the river Wensum, two pair of compound engines and four air compressors, so arranged as to provide alternative means of compressing air for use in connection with *the Shone system. The steam power is provided by a Babcock-Wilcox boiler heated with refuse burnt in two furnaces constructed by the Horsfall Refuse Furnace Syndicate. The destructor furnaces and other works are fully described by Mr. Collins in his paper.*

The Members next proceeded to the well-known Carrow Works of Messrs. J. and J. Coleman, where they had the privilege of seeing the manufacture of tins and casks for the packing of mustard, starch and the other specialities of the firm. The ingenious machinery in operation was inspected with close interest.

From Carrow Works the Members went to the Trowse Main Outfall Sewage Pumping Station, fully described by Mr. Collins in his paper, the principal points of which were closely inspected, special interest centering in the screening chamber containing the screens with self-acting cleaning rakes and rotating rakes to clean the cleaning rakes.

A most interesting round of visits was brought to a conclusion by an inspection of the natural history collection stored in the Castle Museum. The Castle dates from the Norman period, and has played a great part in the history of the city. For many years this ancient fortress was used as a prison, but coming into the possession of the citizens during the present reign it has been converted, at a cost of 16,000*l. exclusive of the interior fittings, into a Museum.*

In the evening the Members dined together at the Maid's Head Hotel, under the presidency of Mr. J. T. Eayrs.

DISTRICT MEETING AT GREAT YARMOUTH.

June 11, 1898.

Held at the Town Hall, Great Yarmouth.

J. T. EAYRS, M. INST. C.E., PAST-PRESIDENT, in the Chair.

THE Members were received by Mr. Councillor Burton, the Chairman of the Sanitary Committee, who, on behalf of the Mayor, offered a very hearty welcome to the Association, and referred to some of the works about to be visited.

Mr. Eayrs thanked the Mayor for his generous hospitality and for the kind welcome offered to the Association.

Mr. J. W. Cockrill was unanimously re-elected Honorary Secretary for the Eastern Counties District.

The following papers were read and discussed.

SOME OF THE RECENT WORKS CARRIED OUT BY THE GREAT YARMOUTH TOWN COUNCIL.

BY J. W. COCKRILL, A.R.I.B.A., ASSOC. M. INST. C.E., BOROUGH SURVEYOR, GREAT YARMOUTH.

IT is now twelve years since the Author had the pleasure of welcoming the Members of the Association to this town. The meeting then held is reported in our Proceedings, vol. xii. pages 119 to 154.

SEWERS.

The work of relaying the whole system referred to in the former paper has stood well, and the purpose for which the work was undertaken has been fully realised, for out of nearly one hundred miles of sewer under the Author's charge, there is not one mile but which is absolutely self-cleansing, and in a town so flat as Yarmouth this may be considered satisfactory. The works of flushing, to be spoken of hereafter, have much to do with this. Since 1886 many extensions have been made to the sewerage works. New pumping stations on the main sewer outfalls, to prevent the tide-locking of the sewers, have been erected, and flood-prevention works have been carried out, the cost of which in the aggregate has been about 25,000*l.* These works comprise about one mile of 5-feet egg-shaped and 1¼ mile of 3-feet egg-shaped sewer, built in concrete with a salt-glazed tile facing—the cost was remarkably low; a sample piece has been set up for your inspection at the depôt. The 5-feet sewer cost 33*s.* per yard run, and the 3-feet sewer 20*s.* per yard run without digging. The glazed surface keeps itself clean, and can very easily be swept down. The low cost is due to the very great facilities we have for making concrete, the clean shingle being delivered on the works, ready for use, at 1*s.* 3*d.* per yard cube.

These sewers were put in to prevent the flooding of some of the low-lying districts, which were found to be flooded in very heavy rains and thunderstorms. The pumping stations which have been erected are placed across the two largest sewers near the outfalls, and the man in charge pumps whenever the accumulation of sewage reaches the height which would mean tide-locking the connections into the main sewer. The pumps at the larger station to be inspected are Gwynne's centrifugal 15-inch and 24-inch, driven by Otto gas engines of 14 and 20 horse-power. They are capable, with their lift averaging 6 feet, of raising quite a million gallons per hour. At the second station two 12-inch centrifugal pumps are put in; the benefit derived from these installations is very great, as not only is the tide-locking of the sewers prevented throughout the year, but in the winter time, when a strong north-west wind is blowing, the tide holds up in the river three and four days at a time to such a height that no sewage can pass out by gravitation.

SEA-WATER WORKS.

These were completed on the lines which were described in the former paper; but the success of the undertaking on all points was so marked that the Committee determined very soon to extend the works, and instead of the 4500*l.*, which the original works cost, more than 10,000*l.* has now been spent. The saving to the Corporation is very great, as the following figures will show.

The cost, including repayments of capital, interest and all working expenses, has been about 600*l.* per annum during the last few years since the extensions, and for this quite 100 million gallons of water has been raised to a height of 45 feet and distributed over the town, or at a cost of less than 1½*d.* per 1000 gallons. The street watering takes about 7 million gallons, and sewer flushing the remainder. The water is supplied free to most of the elementary and board schools in the town for flushing closets, urinals, drains, &c., some fourteen houses also have it laid in for baths and drain flushing.

Flushing is carried out by some 25 automatic flushing tanks, varying in capacity from 3000 to 1000 gallons, and with outfalls of from 9 to 15 inches diameter, besides about 250 flushing valves, varying from 6 to 3 inches diameter, according to the size of the sewer to be flushed; but the Author found that 3- and 4-inch pipes with delivery direct into the sewers will provide sufficient flush for 9-inch pipes, and that sewers up to 15 inches diameter can be kept clean with the larger-sized valves.

The save in the roadwork is very considerable; the sea water has a most beneficial effect on light roads made with gravel or flint. No damage is done on the heavier granite macadam, but a greater amount of cleaning is required in the autumn. The saving on the light roads, spread over about 25 miles, by the use of sea water, is, in my opinion, quite 500*l.* per annum. In addition to the saving caused by the water costing only 1½*d.* per 1000 gallons instead of 1*s.*, there is from 2 to 3 million gallons less used than there would be if fresh water were employed. The save in horse hire in distributing is quite 250*l.* per annum, and the work is much more effectually done. A less number of complaints are received at the Author's office now in a whole season than in a week during the time fresh water was used.

Previous to its introduction the chemists employed by the Water Company prophesied all sorts of evils, as the result of using it for sewer flushing, which have not come to pass. Its use has been most effectual in preventing nuisances from sewer gas, as not only is there the mechanical action of the flush, which scours the sewers out, but there is the change of air in the sewers caused by the large rush of water; and, as there are few sewers in the town but are flushed every other day, this is a very important factor in ventilating and changing the air in them. In the sewerage of the Old Rows, of which there are 145, averaging about 150 yards in length and less than two yards wide, which have been recently sewered, each sewer has its own flushing valve at its head, and is by this means kept perfectly clean.

The length of water mains laid in the streets is now 13 miles, of sizes varying from 8 to 3 inches diameter. All Members of this Association will appreciate the advantage of having complete works of water supply for sewer flushing under their own control, and the convenience of being able to flush without fear of interfering with the domestic supply of the town. The Author has, in his case, the sea to draw from, which is salt, and there are many advantages in using salt water; but there are few towns in which a supply of water exists of not sufficient purity for drinking purposes, yet clean enough for street watering or sewer flushing, which could be made available.

CONCRETE FOOTWAYS.

These have been considerably extended since the last visit of the Association. During the sixteen years which the Author has been responsible for the work of this town, he has laid some 40 to 50 miles. The facilities for obtaining materials are very great, and shingle ready for the work, entirely free of sand, is delivered in the streets at 1*s.* 3*d.* and 1*s.* 6*d.* per yard cube. This permits the path, 3 inches thick, to be laid at a cost of 2*s.* to 2*s.* 2*d.* per yard superficial by the Corporation staff. Contracts, however, have been let and completed at from 1*s.* 8*d.* to 1*s.* 9*d.* per yard superficial. The Author considers this too cheap, and, as the life may be estimated at fifty years, the price of from 2*s.* to 2*s.* 2*d.* per yard will not be considered extravagant. As a proof of its durability, some laid in 1869 hardly shows any signs of wear to-day.

So far the Author has treated of the principal subjects referred to in the paper read before the Association in 1886, and he has now to describe the works carried out since that date. This will be done, not in chronological order but in the order in which it is proposed to visit them.

DESTRUCTOR.

The growing difficulty of disposing of town rubbish has for some years been apparent in this town, and although recreation and pleasure grounds have been formed with this material during the last ten years — the Author has laid down 32 acres of this class of ground on sandy waste land, similar to and partly on our beach—the cost and upkeep of these grounds prevents too great an extension, and the Town Council have reached a point beyond which they cannot go at present. It thus became necessary to decide on some other course. Great difficulty has been experienced for years in getting the farmers of the neighbourhood to take it, and when they did, the sorting and selection created great nuisances; and, as these farmers would only cart it away at times convenient to themselves, it caused an accumulation on the quay, used for deposit about a mile out of the town, of a heap frequently of five to ten thousand tons. The Author was instructed to consider the question of the desirability of conveying and tipping out at sea or of burning. On the first point he found that the cost of plant with its attendant items of interest and sinking fund, the cost of upkeep and towage, with the certainty that in the most favourable winter there would be times when for three or four days it would be impossible to take the hopper barges over the bar, made it as costly as any mode of burning, and the uncertainty was a great drawback, as it involved keeping plant which would depreciate quickly, and for which the quay space was very limited.

The next point raising any controversy was the site. At the present depôt the Town Council had a splendid site with good foundations, a railway close by, the engineer for which was prepared to take the whole of the clinker and pay for it, but as the site adjoined the Isolation Hospital, and was within 100 yards of the workhouse, the Local Government Board refused its consent. The remainder of the land in the neighbourhood being Corporation estate, which is fast being developed for better-class dwellings, it was felt desirable not to do anything which, if only in a sentimental sense, might depreciate this estate. It was determined to erect the destructor on its present site, the foundations of which are very bad: the river Bure adjoins it on the west, and the mean level of the water in the same is above the level of the marsh; the soil is for the first foot or two vegetable mould, then there is about 2 feet of sand which is full of water, and then for nearly 20 feet a soft alluvial deposit, locally known as ooze. The utmost bearing capabilities of the soil about 6 inches from the top, after removing the sod, was by experiment found to be 10 cwt. per foot superficial; the bearing capabilities of the ooze not being more than half this. At the depth of 22 feet is found a bed of good sand and gravel, and borings on the site show this to be at least 15 feet thick. The Author's previous experience in this soil has shown that a large quantity of water is to be met with at a point about 5 feet above the sand level, and the knowledge of this has led to the method of carrying out the foundation work hereinafter described. The very poor quality of the refuse of the town, which contains a large percentage of sand with the contents of some 3000 privies, will give poor calorific results; and the present installation only provides for fixing an 80 horse-power boiler, the steam from which will be used for fans, for forced draught, a dynamo from which light will be obtained for the works, and motors for sewerage lifting at a station near by. The number of cells to be fixed at first is ten of Manlove, Alliot and Co.'s latest type, but the building provides for four additional cells, making fourteen in all; or two cells can be put in with Babcock and Wilcox boilers between them and the end of the present ten cells, so that each boiler could be heated by two cells should any work be found for the steam. The cells are to be fitted with Boulnois' patent charging apparatus, and the furnaces with Messrs. Manlove's clinker furnace.

The chimney is to be 200 feet high; starts square at the base, is octagonal for 50 feet, and then goes up circular; inside it is a parallel tube 6 feet in diameter, with fire-brick lining the whole height, and kept at least 4 inches from the outside shaft; for half its height it is 13½ inches thick, and for the remainder 9 inches thick. The chimney stands in a very exposed position, and the top is kept plain with very little overhang. The exposed position of this building, and the rather unusual practice of having a tipping platform on both sides of the cells, which involved a very wide span for the roof, led the Author to form a level roof in concrete; the cost working out less than it would have done if covered with a slate roof with the usual pitch, beside which the weight is more equally distributed, and the wind forces exerted upon it are very small. The tipping floor and roof of the engine room, which forms the summit of the inclined approach, are formed with trough flooring, covered with granite setts, paved on concrete with asphalt joints and bed. The foundations which are now in progress for the chimney and main buildings are to be on cylinders. The chimney weighs 2300 tons, is to stand on sixteen cylinders, each 6 feet 6 inches diameter, and gives a weight, including the cylinder, of 4 tons 6¾ cwt. per foot superficial on the bed of sand and gravel.

The main building is to stand on twenty-six cylinders of 5 feet 6 inches diameter, giving an average of about 3 tons 5 cwt. per foot superficial on the soil.

The cylinders are constructed of concrete blocks 9 inches thick, built in the ordinary way. At first it was intended to have built them in brick, but the Author found that he could make the concrete blocks cheaper, and build the cylinders quicker with them than with brick, which would have had to be specially made. The blocks are 9 inches thick, 9 inches high, 15 inches long on the face; the lower 4 feet is encased in a wooden drum with a cutting edge, and sunk into the gravel and sand about 2 feet.

Until the main spring of water is met with, the cylinders will be sunk by men filling buckets in the ordinary way, but rather than pump large quantities of water—which would have the effect of disturbing the adjoining cylinder—the work of sinking will be carried on by a circular grab now being made by Messrs. Priestman, of Hull. For the work of levelling the soil at the bottom, and placing the two courses of concrete blocks, a diver will be employed. The joints of the concrete blocks are to be grouted up with liquid cement, which will be passed into the joints through a 3-inch pipe; this will be allowed to stand three or four days to set, when the cylinders may be expected to be water-tight; the water will then be pumped out and the cylinders filled with concrete. Such is the method in which the Author is proposing to form the foundations, but as the work is being carried out without the aid of a contractor, it is subject to such alterations as may be found expedient and likely to give a satisfactory result. It is hoped that before the Members meet, a cylinder or two may be sunk to the required depth; at the time of writing, the only thing likely to hinder this is the delivery of the plant. The foundations of the engine room, which is only one story high, are spread, so that no portion has a greater weight than half a ton per foot superficial on the same.

DEPÔT.

The depôt is by no means complete, or what the Author hopes to see it. Previous to its erection the Corporation contracted for all its horse hire, the scavenging and dust collecting being put out to contract, with the usual result, that the plant employed was of the meanest and filthiest, and the work so badly done that the contractor was continually being fined and his work always under review by the sanitary inspectors. This went on for a considerable time, the economical section expecting a great difference in the cost of the work. After five years, the Author is pleased to say that the cost is not greater than the difference in the wages paid to the men, that the work is much better done, and that nearly everyone is satisfied with the result.

The Corporation has now twenty-four horses.

ISOLATION HOSPITAL.

The town is well provided in this respect. The cholera scare of some few years ago led to the provision of a rough temporary building near the harbour's mouth, and its being kept permanently ready for such an emergency. In addition, about 1½ mile into the country, a group of wooden and corrugated iron buildings have been erected for small-pox; these are somewhat extensive, and although they have now been erected some five years they have not been used. They consist of two pavilions, capable of accommodating fourteen beds each, a receiving ward for three beds, with nurses' room and kitchen, an administrative block and a laundry block. It stands on a good open high site in the country, and if it should be unfortunately needed, will serve effectually to isolate, without any addition, at least thirty patients, while temporary provision could be made inside the ground for twice as many more.

The isolation hospital for fever cases is a permanent erection, the nucleus being erected four years ago, consisting of an administrative block, two small blocks, with male and female wards on each side of a nurses' duty room. A large double ward block similar in plan, and a block for laundry and disinfecting purposes, which also include ambulance store, mortuary, and receiving and discharging rooms for patients, with store for their clothing. The success of this institution and the good work done by it has led the Council very soon to make additions to it, as laid out in the Author's first plan. The extensions now being made consist of eight bed-rooms to the administrative block, a large double ward block of the usual plan, and, what is perhaps a rather unusual feature, a convalescent block for scarlet fever patients; this consists of a day room, two dormitories, two nurses' rooms, bath room and usual offices. The whole of the ward blocks are erected in concrete, the walls outside being faced with pebble panels, brick quoins and dressings, and inside with glazed tile. The Local Government Board recommending a glazed surface internally, led to this method of construction, being the cheapest way a glazed surface can be obtained, the cost being less than the erection of plain brick walls with ordinary plaster, and some 30 per cent. less than the work could be done for in glazed bricks.

Recreation Grounds and Beach Gardens.

The first of these to be seen is not quite complete; it is 18 acres in extent; about 1½ acre has been taken from it, which has been laid out as a nursery for the acclimatising of plants, trees, shrubs and garden material generally—a gardener's cottage and greenhouse being erected on it. The second ground to be seen, which is 8½ acres in extent, has been completed some eight years, has a large grand stand with dressing and refreshment rooms under it, and a tennis pavilion and tea room; the cycle track is one-third of a mile in length. These grounds are managed by a Recreation Committee of the Town Council, and have done much to encourage healthy sport in the town. The gardens along the sea front having been laid out at various times during the last eight years; much opposition was raised to the first one, but since its completion they have been appreciated. The wall protecting them from the sea is about 12 feet high from foundation to coping, and has stood some very severe storms. The cost of the recreation grounds and gardens seen by the Members to-day has been about 12,000*l.*, the land being Corporation property.

THE OLD JETTY.

An addition, 130 feet in length, was made to this structure in 1890. The old portion has historic associations connected with the naval wars in the early part of the present century. The additions were made on cast-iron screw piles 10 inches internal diameter, with a thickness of metal of 1¼ inch, the deck resting on boxed girders, 12 inches deep, while the rolled joists having a span of 30 feet, are 18 inches in depth. The deck is in pitch pine. The total amount spent on this improvement, which includes the widening of the western portion, was about 1700*l.*, and the shelters 500*l.* more.

RIFLE BUTTS, AND ACCOMMODATION FOR VOLUNTEER ENCAMPMENTS.

The South Denes, like all the land outside the town, is Corporation property, granted under a charter of King John. During the summer months volunteer encampments are held on it, and the Council, for the convenience of these encampments, have laid a complete service of water mains over the ground, and have provided permanent latrines for officers and men sufficient for a brigade of 4000.

They have also constructed on the North Denes a 1000-yard rifle range, with twelve targets working on the pit system, room being left in front of the butt for four more; the cost of these items has been about 4000*l.* These volunteer encampments are a source of great attraction to the town, and the military authorities appreciate the work done by the Town Council.

FISH WHARF QUAY WALL.

The Fish Wharf is Corporation property, and was constructed by them nearly thirty years ago, at a cost of about

30,000*l.* A wooden quay was put in on the river front, which, owing to improvements in deepening the harbour, was soon found insufficient, and had to be replaced. This last quay also soon required considerable repair, and in 1888 the Author recommended the Council to put in a concrete quay wall. Messrs. Kinipple and Jaffrey, of Westminster, were called in as consulting engineers. A provisional order was obtained giving power to borrow 26,000*l.*, the estimated cost of the work.

The wall as designed and executed was composed of concrete blocks, the five lower courses 3 feet 4 inches, and the top two were 3 feet 6 inches high. Each block was 3 feet wide on the face; the top three courses were faced with granite rough dressed, and the thickness of the wall is represented by the length of the blocks below.

Course 1 = 9 feet.
Course 2 = 8 feet.
Course 3 = 6 feet.
Course 4 = 5 feet 10 inches.
Course 5 = 5 feet 3 inches.
Course 6 = 4 feet 9 inches.
Course 7 = 4 feet 7½ inches.

The wall was built by removing the wood quay, dredging out a trench to the required depth and width, the soil being allowed to take its natural inclination of repose: this was found to be such that one trolly, carrying the framework of the steam travelling derrick crane used, would just run on the shore side, while the other two ran along on the top of the wall. The crane had a jib 70 feet in length, with a radius of 56 feet, and was one of those employed in building Putney Bridge; it was bought for 500*l.* The wall was divided into lengths of 18 feet, or of the width of six blocks, the sixth block of each tier, being longer than the rest, formed a counterfort. At first a great difficulty was experienced in proceeding with the work, in consequence of not being able to get a sufficiently level bed for the blocks. This was overcome by designing a skeleton shield or cofferdam, which was dropped into place and sunk by removing the soil from the inside by grabs; this prevented the loose sand from running in, and permitted the divers, when levelling the soil at the bottom, to set out their work more accurately. The wall is built block over block with perpendicular joints, so that any irregularity of the foundation does not throw the blocks on to uneven beds. As soon as two courses in a section 18 feet long was completed the joints were carefully caulked by the divers, and thick cement grout was poured down a 3-inch tube through the lewis holes; this was found to make perfect joints. In consequence of a desire not to interfere with the fishing season at the covered market (from September to December), the works had to be pressed on very rapidly. The best week's work done amounted to a length of 90 feet, or five sections of 18 feet. The actual wall building was commenced in August 1890, but during the first few months progress was very slow; the work was completed in September 1891. The works having been pushed on much more rapidly than was expected, towards the completion blocks were laid faster than they were made, and it frequently occured that blocks weighing as much as 7 tons were made and laid in the same week. This led to an accident, at a point about 300 feet from the end, just after the large crane was moved forward, and while a smaller crane was at work on the wall raising soil from barges to fill up behind. A piece about 50 feet long gave way, which, on inspection afterwards, was found to be due to the crushing of the blocks in the third course from the bottom.

The works were completed 1000*l.* inside the estimate, under the Author's supervision, without the intervention of a contractor, the plant for the purpose being purchased second hand and sold at the completion, with the result that less than 500*l.* represented the difference between purchase and sale prices of all the plant needed. The length of the wall is 2100 feet, and its height from foundation to coping is about 27 feet; 17 feet of this is below low-water mark. The wall itself was completed at a cost of about 9*l.* per foot run, the remainder of the money being expended in paving a width of about 40 feet along the quay front.

ELECTRIC LIGHTING.

As early as 1886 the Author had been instructed to, and had reported upon the desirability of introducing the electric light into the borough, and in 1890 the Town Council obtained a provisional order, which they commenced to carry out in 1894; Mr. W. H. Preece, C.B., F.R.S., being appointed consulting engineer.

The cost of the first portion of the installation was 15,000*l.*, but the demand for the light has been so great that at the present time the capital expended amounts to 33,000*l.*, and leave for fresh loans is asked from the Local Government Board, which will make the capital expenditure 40,000*l.* The increase of the demand is shown in the fact that the lamps installed on April 1, 1895, were 1600; in 1896, 5900; in 1897, 8600; and in 1898, 11,000.

Up to the present the works have not paid full charges of interest and sinking fund, there being about 700*l.* deficiency during each of the first two years, and 400*l.* deficiency last year. The rate of progress in connecting additional lights shows that a profit may soon be expected. Last year the earnings on the capital expended was 4⅞ per cent., and, if the Local Government Board would allow longer periods for the repayment of the loans, these works would have paid their way from the first.

The arc lights in the town number 60 (with eleven at the Fish Wharf, which are only used when those on the Beach Gardens are not alight), and are continuous current 1500 volts, 30 lamps in series.

The private lighting is high tension alternate current 2000 volts, with some twenty transformer sub-stations.

The charge made to private customers is 6*d.* per unit, to churches, chapels and public elementary schools 4*d.* per unit, and to motors, a sliding scale varying from 1½*d.* to 3½*d.* per unit.

The plant in the station at present is two 150 horse-power, and two 200 horse-power Babcock and Wilcox boilers with a Green's economiser.

Four arc lighting machines, each for 30 lamps, are driven by cotton ropes from two Willans engines. Three 75 K.W. alternators are driven direct from Willans engines, and one 150 K.W. alternator driven direct from a Peach engine made by Messrs. Davy, Paxman and Co., of Colchester.

The condensing plant was made by Messrs. Allen, of Bedford.

The whole installation has been put in by Messrs. Crompton, of Chelmsford. The mains are armoured cables made by the British Insulated Wire Company, of Prescot. Since their commencement the works have been under the able management of Mr. A. W. Ranken, Assoc. M. Inst. C.E.

WORK UNDER CONSIDERATION.

The Author has recently reported on a question of the provision of a system of electric tramways, a portion of which is extremely necessary to develop the Corporation estate at the north end of the town. The system recommended was the overhead trolly system, and the estimate for the work was 36,000*l.*, but it was not necessary that the whole should be carried out at once; about 29,000*l.* would have formed a complete scheme suitable for the town, but this matter is placed in abeyance for a short time. The principal item, however, before the Town Council during the last nine months has been the question of providing a pier and pavilions, for which the Corporation obtained power in the last Session of Parliament; the site selected was that occupied by the old jetty. The Author prepared a considerable number of plans and designs, one set being approved by the committee entrusted with working out the details of the scheme. The estimated cost was 70,000*l.*, with the possibility of reducing to 60,000*l.* without marring the design too much.

The scheme as approved by the committee comprised a pier 660 feet in length, with large T end, a landing stage 900 feet long surrounding the T end, a large quantity of shelter accommodation and band stand. The area of the floor space of pier being 67,500 feet, the pier was to be constructed with cast-iron screw piles and wrought-iron girders, the landing stage and deck throughout was to be in jarrah. At the west end a large piece of ground, semicircular in shape, was to be enclosed, on which was to be erected a pavilion containing arcade, a large hall, 85 feet by 30 feet, with requisite appurtenances and large galleries, and capable of seating 3000 persons. Also a large number of refreshment rooms and tea rooms, with rooms suitable for small entertainments, a swimming bath 35 feet by 120 feet, and small baths, with room for extension, so that Turkish and other baths could be added.

The first floor contained a small hall for seating 600 persons, a large reading room, and some 550 feet run of covered balcony.

The intention was to have constructed the whole building in brick and terra-cotta in a permanent manner, so that the upkeep should be as small as possible. A combination of vested interests, and the sentiment that the present old jetty was free to the public, prevented anything being done. Some of the plans and models prepared are on view—representing several months' work, without any result. In this matter the Author feels he has the sympathy of his professional brethren.

DISCUSSION.

Mr. E. G. Mawbey: In Mr. Cockrill we have a very able colleague indeed. It is not often that we see anything superior to the beautiful drawings we have here. With regard to the town of Yarmouth, I remember, in 1882, when I was worked down, coming to Yarmouth and getting a new lease of life. It is very satisfactory to know that while some corporations are wearing us out, there is another catering for our health. With regard to the sea-water supply works, I must say it is really a splendid installation. I have had the opportunity of availing myself of the kindness of Mr. Cockrill with respect to some of the works in Yarmouth; and I may say here he never seems to tire of giving to his brother engineers any information he may possess. Undoubtedly this supply of sea water at 1½*d.* per thousand gallons is a great advantage when you consider that the town was being charged so heavily by the water company for water for public purposes. With respect to concrete paving, Mr. Cockrill was almost the pioneer of this class of work. Of course he is fortunate in possessing all the shingle he requires on the beach, but he has utilised it in the best way and to the utmost advantage. If Mr. Cockrill cannot speak of 50 years' life for this class of pavement, he can guarantee 30 years' life.

Mr. Cockrill: Some of the paving was laid in 1869.

Mr. Mawbey: I knew it had been a great success. As to the destructor, I must admit I am surprised there is not more said about utilising the waste heat. I notice the refuse is of a poor quality, and that there are 3000 privies, so that the calorific value would be low. In a town where the servants are careless, and where you are nearer to the coalfields, and get plenty of unburnt cinder left in the refuse, I consider it is a mistake not to utilise the heat contained in it to the fullest extent. I have gone into the question for Leicester, where we carried out some tests, and I am recommending it there to produce the power as far as it will go, and it will go a very long way, for electric traction. A sub-committee of the Leicester Corporation has been round to see several destructors, notably Cambridge, Shoreditch and Luton, and, taking the character of our refuse into consideration, there does not appear to be any difficulty in getting at least 3 horse-power per ton of refuse burnt per 24 hours. That is based on the assumption of 1 lb. of refuse evaporating 1 lb. of water, and allowing 30 lbs. of water per indicated horse-power per hour. But if you take 20 lbs. of water, instead of 30 lbs., you get 4½ horse-power per ton of refuse burnt per 24 hours. From what I have heard of Cambridge, that has been achieved there. It is not desirable, however, to rush 10 to 20 tons of refuse per day through a destructor cell. In my opinion the first duty is to completely burn the refuse so as to avoid any nuisance in the form of offensive smells or gases, and the second duty is to get the maximum amount of steam out of the burning of the refuse. I am advising at Leicester that to do that we should not allow more than about 6 tons per cell per 24 hours. We are adopting the forced draught system, and of course could get more through the cells if we thought it desirable. If you estimate a quarter of a ton of refuse per head of population per annum, that would give you about 25,000 tons of refuse per 100,000 of population, which is equal to, say, about 300 horse-power, which is well worth making use of. I have seen the isolation hospital—a building well worth visiting—and the recreation ground. I should like to call attention to one more matter. Mr. Cockrill has invented a patent tile. I have been all about Yarmouth, I have seen some splendid sanitary work carried out with it; and I have also laid a length of sewer with these tiles in Leicester. I have a very good opinion of the invention, and should like to bring it strongly before our Members. It appears to me that you were very well advised with respect to electric lighting. It is a fortunate thing when a town has been wise enough to consult engineers of the eminence of Mr. Preece, the present President of the Institution of Civil Engineers, and his very able son. With regard to the system adopted, I may say they have adopted the same at Leicester, and are well satisfied with it; though they have not got the Willans engines. Yarmouth, if not in the heart of England, is certainly in the front rank of municipal and sanitary enterprise. I have much pleasure in moving a vote of thanks to Mr. Cockrill for his paper.

Mr. J. Lobley: I have very great pleasure in seconding the vote of thanks to Mr. Cockrill for his paper. I have known Mr. Cockrill for a great number of years, but I have not had

We have
gust and
ecause it
time.
of being
two with
ading the
n myself,
I quite
thing to
tions for
nvenient
Corpora-
may not
I have
burning
ter will
return
You are
kers for
stoking
ion you
t there
rom the
e than
ctories.
tructor
yards
t half
like
there
uite

a very much longer period is allowed for the repayment of the loan. In our case, where a much shorter period has been allowed, there is not the same necessity to pay into a reserve fund in addition to the sinking fund account. After all it is not so important to have a long period for the repayment of electric lighting loans, and if the ratepayers do not get so large a benefit from the works during the early years, they get it after the loan is paid off.

Mr. E. J. SILCOCK: I desire to call the attention of the Members to the extremely low cost of the work which Mr. Cockrill has carried out. There is no doubt Mr. Cockrill has a great advantage in having so much shingle and material for making concrete ready to his hand, but he has made the fullest use of that material, and the result has been that Yarmouth has secured works on very economical terms. I think you will look at the cost of the sewer mentioned on the first page of the paper, the 5 feet by 3 feet sewer cost 23s. per yard run: that fact speaks volumes for the way in which Mr. Cockrill looks after his work. Then in the case of the sea wall, which is illustrated at the end of the room, the work has undoubtly been extremely cheaply done by administration. I happened to be here once or twice when that work was going on, and Mr. Cockrill showed me the work in progress, and I was very much struck with the way in which he handled that job. With regard to the destructor, Mr. Cockrill must have great courage to build a chimney 200 feet high on such a foundation as he describes; and it will be very interesting to see the way in which these cylinders have been sunk. I have some experience of lead foundations, for Lynn is not all solid rock, and I had to put up a chimney 150 feet high, with which we had considerable trouble to secure a proper foundation. But in that case the solid substratum is somewhat lower than Mr. Cockrill has to go. I should think that 4½ tons per superficial foot for a subtratum of sand, is quite as heavy a load as should be put upon it. I should like to ask whether the 2300 tons, the weight of the chimney, represents the dead weight of the chimney only, or whether there is any allowance for wind pressure. The wind pressure will increase the pressure at the base of the chimney to a very large extent; therefore it is important to know whether the wind pressure is included or not. With regard to the isolation hospital, that is a work which we shall see, and I am sure we shall all admire. I saw it some months ago, and I can quite endorse what Mr. Mawbey said as to the tiles; I am quite of the opinion that they are of value to engineers, and a capital thing. I have used them myself, and find you can make very good work with them at a cheap rate. You will see the hospital to-day, and I am sure it will be very much admired when the cost of the building is taken into consideration. We were going to build a joint hospital in Lynn, and were going to use the tiles, but unfortunately the scheme fell through, as we could not come to terms with the other authorities. As to the quantity of power which can be got from a destructor, I think Mr. Mawbey put the limit to the calorific value when he says that 1 lb. of refuse will evaporate 1 lb. of water. That is as high a result as has ever been obtained in practice, and quite as high as can be reckoned upon when going into the question of the power obtainable from a destructor. In large towns this means a good deal of power, no doubt—several hundred horse-power—but not nearly sufficient to light up the whole town with electric light, and when people talk of lighting towns with power from refuse destructors, it is going too far.

Mr. HAYWOOD: I should like to ask a question as to the sea-water supply. Mr. Cockrill says the sea water costs 1½*d.* per thousand gallons, and the town water 1*s.* per thousand gallons. I should like to ask whether the sea water is conveyed to different parts of the town in the same way as the water company's supply. It may cost less than the fresh water, but if Mr. Cockrill has to cart it a distance of two or three miles instead of two or three yards, it will make a considerable difference in cost. I should also like to ask why the water costs 1*s.* per thousand gallons; it seems a very high price to pay for water in a town like Yarmouth. I ask these two questions because I find in my town, after raising the water 350 feet, we can get it for 4*d.* per thousand gallons.

Mr. MAWBEY: You don't have any dividends to pay.

Mr. F. BAKER: There is only one point I should like to ask, that is, the cost of the labour for flushing per month.

Mr. NETTLETON: It is mentioned in the paper that these sewers are self-cleansing, but flushing is adopted. Is the flushing for the purpose of cleansing the whole area of the sewers, or checking any emanations from the sewers so as to prevent the sewer gas permeating the air?

The CHAIRMAN (Mr. J. T. EAYRS): There are one or two points to which I wish to refer. The first is on page 155, with regard to the sea-water works. Mr. Cockrill says that he found that 3 and 4-inch pipes with delivery direct into the sewers will provide sufficient flush for 9-inch pipes, and that sewers up to 15 inches can be kept clean with the larger sized valves. I should like Mr. Cockrill to state the average head at which the water is discharged through these pipes, because that makes a very great difference to the quantity which the valve would discharge. If he has a considerable head of water no doubt it would be sufficient, but not otherwise. I think Mr. Nettleton has fallen into an error with regard to the sewers; or if not, I have done so. I take it the sewers are made self-cleansing by reason of flushing and not by gradient. Perhaps Mr. Cockrill will say which view is right. Mr. Cockrill says there is a saving on the light roads by the use of sea water of quite 500*l.* per annum, spread over about 25 miles. I should like to know why this great saving is effected, whether it is the effect of the sea water in keeping the roads bound, or moist, and preventing them breaking up, or whether it is from some other reason which I do not quite appreciate at present. With regard to the cost of 1½*d.* per thousand gallons for sea water, as compared with 1s. per thousand gallons for water supplied by the water company, I think it is only fair to point out that the water company has had to incur considerable expense in the sinking of wells, the pumping of the water to a greater height, and the carrying of it a longer distance, and then there is also the profit on the undertaking to the shareholders. Then I should like to ask whether in this 1½*d.* per thousand gallons for sea water there is any allowance for capital outlay and interest and sinking fund payments. I should also like to ask Mr. Cockrill, in connection with the destructor works, if he could give us the cost of the chimney, and also the length of the cylinders of concrete. The diameter of the cylinders and the thickness of the concrete blocks are given, but it would be useful to also have the length. I am sure Mr. Cockrill must have been a very busy man to have carried out all these works in so short a period, and I must congratulate him upon carrying out the sea wall by administration at so cheap a rate. We are much obliged to him for this paper, for all he writes is of practical value, and consequently we are much indebted to him for this contribution.

The vote of thanks having been accorded unanimously,

The **Chairman** said: With regard to the use of sea water, I notice that fourteen houses have a supply laid on. Have you any power to do this, as there is a water company possessing statutory powers for the supply of water for domestic purposes?

Mr. **Cockrill**, in reply, said: With reference to waste heat, I have for ten years been considering the question of destructors, and I have seen almost every destructor in the country, and certainly the latest types. I am glad to observe Mr. Mawbey's reference to Cambridge, where the best that has yet been done in connection with destructors has been accomplished. They could not generate steam for electric lighting works, but if the company adopted a system of tramways they would put in two boilers from which to generate steam for electric traction. In regard to the chimney, it is quite true that I have thought of a steel chimney, but as the Local Government Board would only grant a loan for five years, I have abandoned the idea. The dead weight of the chimney was about 4½ tons per foot superficial, but the subsoil and gravel below would take 9 tons if not 11 tons per foot. There was then a good margin without giving the actual figures of wind pressure. Mr. Haywood has asked a question as to the distribution of sea water. The pipes are laid all over the town, but the hydrants are in such positions that the water carts have a shorter distance to travel than in connection with the company's pipes. If the companies had reduced their charge to 6*d.* there would have been no sea-water scheme, but they refused. In reply to Mr. Baker, I might mention that labour is cheap in this town, but it is apt to be inefficient. In reply to Mr. Nettleton, I have to explain that the sewers are self-cleansing with the aid of the flushing. Mr. Eayrs has raised the question of the head of water discharged, which was from 20 to 30 feet. The advantage of using sea water on the roads is that it serves to keep them moist and well together, but otherwise there is very little difference between sea water and that of the company. There is a saving of 30 per cent. in the cost of maintenance, and 1½*d.* per 1000 gallons covers all charges, including those of capital and interest, the total inclusive annual cost since the extensions being about 600*l.* The length of the cylinders used in the destructor foundations was about 24 feet. They would be built of rings of concrete and then filled up with concrete inside.

ON THE ABUSE OF POWER HOUSES.

By W. H. PREECE, C.B., F.R.S.
President of the Institution of Civil Engineers.

There is a great tendency in the present day to multiply *Power Houses*—or *Central Stations*, as they are more frequently called—unnecessarily. This arises from various causes.

1. From want of foresight in predicting the growth of electric industries.
2. Economy in selecting land we have, rather than pay money for land more suitable by position but which we have not.
3. The restriction of legislation in confining operations to a defined area.
4. The growth of other industries side by side, especially tramways and railways, worked by electric traction.

These causes have led to the original power houses being designed too small, and on space too confined; and to the subsequent construction of other power houses, further afield and more extended; and even to the necessity of going to positions outside the original area secured by provisional order.

But worse than this, different industries have been promoted by rival and opposing interests. Trade competition and patent rights have led to the construction of power houses side by side, until we see the absurdity of one installation being worked at night to supply energy for electric light, and another installation generating energy during the day for traction purposes being built practically on the same site; whereas not only can the power be generated conveniently and economically by the same plant, but the two energies can mutually assist each other, so as to reduce considerably the work cost per unit generated. This is what the Author means by the abuse of power houses. The man who causes two blades of grass to grow where one only grew before is called a benefactor of his race, but the local authority which deliberately allows two power houses to be built where only one is needed is a disturber of the peace.

It is very well affirmed by experience, that the greater the plant, and the larger and more continuous the output, the cheaper is the cost of generation per unit. It may be said, roughly, that if a given plant, say 10,000 kilowatts, working at its maximum load, on the average three hours a day, produces electrical energy at one penny a unit, it will do so at three farthings per unit if it works six hours a day, one halfpenny per unit if it works twelve hours per day, and less than one farthing per unit if it works twenty-four hours the day. Hence, distinctly, concentration of power is financially desirable if it has the effect of lengthening the daily maximum output of the plant. One large station, conveniently built on the water side, where coal can be delivered alongside, by rail or by sea, at its cheapest; where water is abundant and available for condensing; where ashes, clinkers and dirt are easily barged or carried away; where we have one control and one staff, is clearly the ideal power house for economy. And it also puts a stop to any cause of nuisance. The cartage of coal and rubbish does not impede traffic. Vapour clouds do not offend the eye, and apparent rain, in the form of condensed drops of water, does not damage one's garment or need the raising of umbrellas; vibration, noise and smells, cease to be causes of vexatious litigation; additional chimneys do not disfigure the view. The question of securing a site is very much simplified. Hence comfort and convenience attest the value of the concentration of power plant in one locality.

In these days of high electrical pressure, whether continuous or alternating, the position of the power house is not a matter of serious import. In the early days of the new electrical industry, it was a question of economy of distribution to place the working plant in or near the centre of the area to be served, but now it is of little consequence where it is placed, within a limit of a few miles. The difficulty is a legal one, but even this has been considerably modified by the action of the recent Joint Committee of the Lords and Commons, who recommend that compulsory powers for purchase and for wayleaves for mains shall be allowed to those who find it necessary, for public purposes, to establish their power house outside their own area of supply.

The whole tendency of recent legislation has been to favour local authorities, and to facilitate their acquisition or induce their acceptance of those municipal duties which include the conduct of industries which affect the whole community, like the supply of water, of light, and of general locomotion. The success of the electric light industry in the hands of local authorities is beyond dispute, and some of our large cities are now taking up vigorously and with great spirit the working of their tramways by electric traction. The ultimate success must be the same. These corporations, with their provisional orders and their electric light installations, have already the legal powers and the means to supply electrical energy. This is their right, and a valuable property it is to them. No one contests their claim to do it, but there are corporations who have not yet acquired the working of the trams in their localities, but who have the right and the means to supply energy, and in these cases the right to supply energy to tramways is contested. If it were to succeed, and the tramway companies allowed in all cases to build and work their own power houses, we should see the absurdity of two buildings existing where only one was needed, of two causes of nuisance perpetuated where none need exist, where the travelling public would suffer from higher fares and the undertakers voluntarily accept the responsibility of generating their energy at a needless cost.

There are other advantages in combining an electric light and a tramway plant. There is but one question of site, and but one management. There is only one set of boilers and one steam-pipe system, for the loss of energy by radiation from steam pipes is very large, and therefore of some consequence. There is, moreover, less reserve plant needed.

The supply of energy to work the tramways would enable the undertakers to reduce the price per unit to the electric light users by probably one penny, while they could at the same time supply the tramway company, if such exist, as cheaply as the company can generate the energy themselves. Moreover, when the time arrives for the local authority to take over the tramways they would not be saddled with two power houses.

The Author thinks this abuse of power houses is a subject that well deserves the serious consideration of the Association of Municipal and County Engineers.

DISCUSSION.

Mr. A. H. **Preece**: I should like to make one or two remarks on electric installation. The points I wish to call attention to in connection with the electric lighting installation are really the financial results, those are what appeal to you probably more than any point in connection with the plant. As Mr. Cockrill has pointed out in his paper, we have earned this year nearly 5 per cent. I would also like to point out that the total profits of 1897 have been 2320*l*, and the total interest on capital has been 2224*l*., so we have covered our interest on capital expended by 96*l*. The only loss that has been sustained has been that of the sinking fund, which has been referred to by several speakers. I quite agree as to the injustice of expecting a new industry like this electric lighting industry to start putting by 2 or 3 per cent. as a sinking fund. Mr. Lobley made one remark as to throwing certain plant on the scrap heap. I may reply if he did that, he did not get any expert advice. The repairs and maintenance at Hanley come to ½*d*. per unit, and here they only come to ⅛th of a penny per unit. I am perfectly convinced that what plant we have here is good for the period of the loan, twenty-five years. It might get out of date, but as to its working power it will be as good in ten years time as it is now. Another point upon which we have been seriously handicapped in Yarmouth, has been the low charge we fixed upon for the public lighting. We are charging 16*l*. for an 11-ampere lamp per annum. I find by comparison with other stations where a large profit has been made, that the charge for public lighting is much higher. All we get for the public lighting is 901*l*., and when you take into consideration that the cost, including interest and sinking fund, is 1100*l*., you will see that the Lighting Committee are getting very well served by the electric light department. As regards the plant itself, I hope you will have an opportunity of seeing it during the afternoon, and I think you will all agree that it has done very well during the time it has been down. I hope Mr. Cockrill will put up as good a chimney for the destructor as we have put up for the Electric Light Works. As to the progress of electric lighting, the curves show how the working goes on. You will observe from the working that we are making a very respectable profit between the months of October and February. We have a very large and short load during the season in August and September. This includes a good many expenses, because it necessitates having the full power on for a very short time.

Mr. E. G. **Mawbey**: I should like, even at the risk of being considered to be speaking too often, to say a word or two with respect to this interesting paper by Mr. Preece. In reading the paper I must say it came somewhat as a "damper" upon myself, for it is against what I am advising at Leicester. I quite agree with Mr. Preece that it would be an unwise thing to allow any company to put down electric power stations for traction purposes, where a Corporation has already a convenient central station for lighting, and that it is better for a Corporation to undertake the working themselves, although it may not be in connection with the lighting. If, however, as I have previously said, we can evaporate 1 lb. of water by the burning of 1 lb. of refuse, and the evaporation of 30 lbs. of water will produce one horse-power, that means a very handsome return in a town like Leicester. Look at it in another way. You are bound to burn this stuff, and you have to provide the stokers for firing it; therefore you can charge the full value of the stoking as well as of the fuel in horse-power. For electric traction you must transmit the power, and in whatever way you do that there is a great loss. Therefore if you use the power obtained from the destructor for electric traction it is of much greater value than it would be to supply power to neighbouring manufactories. For instance, if you have got 150 horse-power at the destructor and you cannot utilise it there, but perhaps could 500 yards away, probably the manufacturer there can produce it at half the cost at which you can afford to transmit it. I should like to ask Mr. Preece if there is any objection, provided that there is one central destructor electric power station—and I quite agree with him that it is necessary to have your reserve or stand-by plant there, and not at half a dozen different stations—to utilising the power produced at the various destructors in different districts, situate near the main tram lines, as supplementary power stations for electric traction, by putting down simply an engine and dynamo at each place and supplying electric current into the cables at the nearest points, much in the same way as pumping water into a system of town mains at pumping stations in different parts of the town.

Mr. Lobley: I should like to second the vote of thanks to Mr. Preece for the paper and also for the remarks he has made in supplement to it. This is a subject to which I have given a great deal of attention. I must not consider myself an expert but rather a disciple; though the question has been under my careful attention for a great many years. I quite agree with Mr. Preece that no authority having both the tramway traction and the lighting should dream of having two separate power houses, excepting of course in very large cities where possibly it cannot be avoided. Unfortunately we are in a different position in Hanley. We were three years in advance with our electric lighting station before electric traction came on as it is now; and unfortunately the tramways run through several towns, which are all extremely jealous of the central town which I represent, and every attempt on our part to supply the tramway company with current has met with very great opposition. In fact it aroused such feeling in the other towns that it had to be dropped. Since then we have had another company seeking to extend the tramways, and they asked the terms upon which we would supply power from our electric light station. They would only offer us a very small figure, though I informed them that at Dover the tramways were paying 3*d*. per unit. I went very carefully into the matter, and I do not think there would have been any advantage to ourselves if the proposal had been concluded. Their proposal was for the power to be supplied on a sliding scale, which would range from 2*d*. to 1*d*. per unit according to the quantity supplied. Terms were also to be imposed providing for a separate plant for traction purposes. I should like to ask if there are any instances of the same engines and dynamos supplying both light and power for tramway traction simultaneously through the same mains. The system I had suggested was to use the alternating current which we have in operation, and transform it by rotary transformers into a continuous current at sub-stations, placed at intervals of about 2 miles. That would not meet their wishes unless we set aside alternators specially devoted to their purposes. I have had opportunities of seeing combined arrangements in operation in other towns. At Dover they have a separate generating plant entirely. Also at Havre, where the electric light company supplies the tramway company with energy by meter. There they have a separate plant—continuous for the tramways and alternating for the electric light. The savings consist in buildings, boilers, chimney stack, stores of all kinds and staff of electricians and workmen. But even though these may be all the advantages, it is quite sufficient to make it desirable that there should only be one electric power house in a town. The only other point I wish to refer to relates to the previous discussion. I did not say that I had put any plant on the scrap heap; but that I should like to put some there. The plant at Hanley is exactly the same as Mr. Preece is using at Yarmouth and Worcester and other places, namely, alternating current with sub-stations. It is a remarkable thing that at Wimbledon a few weeks ago I pointed out that Mr. Preece had put down there the same system which I have had in operation at Hanley for the last four years. I shall be pleased to be assured by Mr. Preece that there is no probability of this system being superseded by the great advance which has been made in electric lighting by the continuous current system. I am now alluding to high voltage lamps and the three wire system, with which you cover a very much larger area than was done five or six years ago.

The Chairman: I should like to add my thanks to Mr. Preece for having written the paper, and to his son for having attended here to day. With regard to the paper itself, I quite agree with the remarks that have been made, for I think there is considerable waste both in the construction of building and also in the distribution of power. I have a case in my own mind of a group of towns where a company is proposed to be formed for supplying electrical energy for traction, industrial and lighting purposes from one central station. I think this paper from so eminent an electrician as Mr. Preece comes very opportunely to show that it is very desirable to do so. Although one company would supply the energy to several towns there is no reason why the Corporation and Local Authorities should not allow them to do so if they themselves can buy the electricity cheaper from a central company than they could generate it themselves. I believe the company I refer to is prepared to supply the current at 1*d.* per unit; and I feel quite sure that small Local Authorities could not generate it and supply it at that rate. I say nothing as to the cost of erection of buildings and chimney stacks, because it is quite evident that one building would be better and cheaper than half a dozen, and of course the central station would be at such a point as to be provided with fuel on the most reasonable terms.

The vote of thanks was then unanimously adopted.

Mr. PREECE, in reply, said: There are only two questions to reply to. As regards Mr. Mawbey's question as to the use of little destructor stations scattered over a town, there is no objection to that at all, because it is not to all intents and purposes an electric light station but a dust destructor, where you want to utilise waste steam. The question of one station does not necessarily apply to towns of over 60,000 to 80,000 inhabitants. It is found by engineers generally that a station of from 4000 to 5000 horse-power is about the maximum size that gives good ordinary results. If you have to put down a station of 10,000 horse-power you may as well put down two stations as one. Therefore when you come to a town of 100,000 or 200,000 population it does not apply. As to the utilisation of the plant for light, and power, it is only possible to use one engine as the load is continually varying and would cause a fluctuation of light which would be objected to by your consumers. But there is no reason why the same plant should not be used one day for one purpose, and the next day for another purpose. The type of plant and engines is precisely the same for both purposes. On the other matter I should like to point out that the question of separate engines for the purpose is not of very great importance, except for the case of special plant. Two smaller engines will work with the same economy as one larger one; and two engines of 200 horse-power each will be quite as good as one engine of 400 horse-power. The economy in a combined light and power station is the economy in buildings, boilers, and the use of one staff, and really the question of the staff is the greatest of them all. Separate cables are absolutely necessary, you cannot run on the same cable.

The Mayor of Yarmouth entertained the Members to luncheon in the Town Hall on their arrival from Norwich, whence they proceeded by steamboat "Jenny Lind" generously provided by Messrs. Cockrill and Collins.

At the conclusion of the discussion on the papers the Members proceeded to view the different works, in progress and completed described by Mr. Cockrill in his paper. The site of the Destructor

Chimney, and the sinking of the cylinders to form the foundation, were inspected with close interest; and there was a universal admission of the difficulties which Mr. Cockrill had to meet and overcome. The next visit was to the Isolation Hospital, and here the opportunity was taken to see some of the tile work to which Mr. Mawbey had drawn attention earlier in the day in the course of the discussion on Mr. Cockrill's paper. The Recreation and Beach Gardens, which are now among the most attractive feature of Yarmouth front, the Sea-water Pumping Station, the Electric Light Station, and the new concrete Quay Wall at the Fish Wharf were visited at Yarmouth.

ANNUAL MEETING AT EDINBURGH.

June 30, and July 1, 1898.

THE PRESIDENT'S ADDRESS.

BY O. C. ROBSON, M. INST. C.E.

IN addressing you upon this occasion, my first and pleasing duty is to extend my heartfelt thanks to the Council and Members of this Association for the high honour I have received at their hands, in being elected to the Presidential Chair for the ensuing year. It is a position of which I feel justly proud, and although I may not hope to emulate the work of the eminent men who have preceded me, it will always be my earnest endeavour to enhance the interests of the Association to the utmost of my power, and steadily to maintain the high reputation it has gained in the past.

The duties of the municipal engineer and surveyor are so varied, and embrace so many items of administrative and constructive work, that a large amount of time would be required to deal with them in their entirety in this address, and I much fear the patience of my audience would be sorely tried were I to attempt so bold a measure.

Some idea of the magnitude of these works may be obtained by reference to the last Annual Report of the Local Government Board. The report shows, that since 1871 the local authorities have incurred upon the strength of their borrowing powers an indebtedness of over 150,000,000*l.* for sanitary works and other improvements. This vast sum is in addition to, and quite independent of, the annual cost of works defrayed from current expenditure. The progress of sanitation since the constitution of the Local Government Board may also be fairly gauged by the figures in this report, the amount of the loans to sanitary authorities sanctioned by the Local Government Board in 1871 being 267,000*l.*, whilst in 1896 the amount was upwards of 5½ millions.

The nature of these works for which the municipal engineer is responsible is varied, comprising road-making and road-maintenance with concurrent bridge and viaduct work, tramways, sea and river walls, design of sewerage and water systems, treatment of sewage, public lighting, erection of isolation hospitals, public offices, free libraries, mortuaries, markets, and other buildings incidental to municipal administration, the laying out of public parks and pleasure grounds, fire brigade control, and supervision of new buildings.

In addition, the municipal engineer must advise on all Parliamentary promotions affecting his district, and have a fairly intimate knowledge of the various acts now relating to public health.

Upon the competency, energy and skill displayed by the officials discharging these duties, the comfort, convenience and health of the community largely depend, and the responsibility thus accepted is well known by those in this room to be no light one. It is nevertheless, I believe, one that is taken up with enthusiasm by all of us. We feel that we are members of a grand profession, which tends to the benefit of our fellow man, and I am glad to believe that this ever present desire of the municipal engineer to further improvement in sanitary and kindred sciences is each year becoming more recognised and more appreciated by those whom we serve.

In the summary of duties before mentioned, there are some matters that have been specially interesting to the municipal engineer during the preceding year, to which perhaps I may be allowed a brief reference. Amongst these, that which has taken priority and has been most discussed is the now familiar subject of the purification of sewage by biological means, as exemplified by the septic tank, Mr. Dibdin's system, Colonel Ducat's filter, and others.

This very recent discovery of the valuable assistance rendered by the micro-organisms in tank and filter, must be deemed the more extraordinary if it be remembered that the much-condemned cesspools of olden days, with filter tank attached, evidently were adaptable, if they did not contain these natural media, for the breaking down and after-oxidation of organic matter in the sewage to be treated; but presumably the generation, and, if I may so say, the intelligent nursing, of these minute organisms, pent within the walls of tanks or filters, was not then understood, and it is only quite recently that this system of nature has been adapted to hygienic laws. The absence of sludge, and the accompanying difficulty of its disposal in the neighbourhood of large towns, is especially an important element in the system, and will in itself greatly tend to economise the expenditure upon sewage treatment.

Should the promise given in several of the experimental works prove as successful with the varying flow and every description of sewage, or in the more comprehensive scheme for Exeter, as recently sanctioned by the Local Government Board, it will indeed be a long stride towards the solution of that difficult problem of the efficient treatment of sewage under all conditions. Especially will it be a boon to those towns discharging into rivers with a small catchment area, and where land treatment is impossible by reason of the great price or unsuitability of soil. With suitable land available, however, and at a moderate cost, it is probable that the rotation of nature, as illustrated by the land treatment, from earth to plants, plants to animals, with return from animals to earth again, will in many places retain its early pre-eminence, and the economy of nature thereby be maintained.

The whole subject is now doubtless in a somewhat experimental stage, but will in all probability receive the earnest attention of the Royal Commission, just formed, for the consideration of the treatment of sewage, and whose report is awaited with so much interest and anxiety by municipal engineers. At the inquiry much valuable evidence will be received upon this important question; but with all submission, it appears that, beyond this, some assistance might be rendered to the Commission if experimental works were provided in the near neighbourhood of the Metropolis, where the several systems of biological treatment could be panelled out, and practically investigated and tested for a certain period of time, under exactly similar circumstances as to character of sewage, extent of flow, climatic conditions and other situations of identity. With careful and intelligent daily supervision, investigation and systematic analysis, much valuable testimony might be gained for presentation to the commission. The cost of the construction of the necessary works need be but small, and should not stand in the way of what I believe would eventuate in most useful results.

The necessity for more careful consideration in the system to be adopted for the treatment of sewage is becoming each year intensified by the rapid increase of population, by the addition of legislation relating to river pollution, and the more drastic supervision accorded by the river authorities with regard to sources of pollution. Where a mere perfunctory examination of a stream was accorded in former years, a duly qualified staff of inspectors is now appointed, constant analyses are made, and the riparian authorities are kept closely up to the mark. Unfortunately, however, for many towns this mark is not a fixed one, i.e. no uniform standard is established as to the extent of impurity allowable in the effluent or filtrate discharged into the stream.

A distinction in the standard as between discharges above and below water intakes upon a river is understandable, but with similar tributaries to a parent stream, but supervised by a separate body of officials, it does appear incongruous that a varying standard of purity, or rather of impurity, should exist, depending only on the individual opinion of the expert advising the particular river authority.

A particular standard was certainly prepared by the Rivers Pollution Commission some years since, dealing more especially with the solids in suspension and solution, and the albumenoïd ammonia but this is practically a dead letter, and no known standard is now available for many towns discharging into non-tidal waters.

Exceptional standards of purity are demanded in the case of those towns or districts that are situated upon sluggish streams possessing flat declivities and shallow inclinations from the watershed, with a maximum amount of absorption and a minimum contribution of rainfall. The oxidation of the organic matter in the effluent is thus considerably diminished by the paucity of pollution from surface waters and by the sluggish character of the river's flow, casting especial burdens upon the towns thus situated, where the population may be large and the volume of sewage altogether disproportionate to the natural flow of the stream into which it is discharged. In such cases as these a highly insanitary condition of affairs occurs, and of late much expensive litigation has ensued with regard thereto.

To avoid this, it is a point for consideration whether a more perfect, if not more economical, solution of the sewage difficulty would not be arrived at in various parts of the kingdom by the extension of the system of valley sewers or effluent channels receiving contributions from the various towns *en route* to a final discharge into the sea, tidal river or parent stream as the case may be. The treatment of the sewage by each separate township, with discharge of filtrate into the main valley conduit, or the conveyance of the combined bulk of crude sewage far away from habitations for treatment at the lower end of the valley, must be determined by the physical circumstances of the valley and questions of policy between the authorities.

There are, however, at the present time some isolated schemes of this description, controlled by joint sewerage boards, which might with advantage to the general health and comfort of the public be more generally adopted in some densely populated neighbourhoods by co-operation amongst the riparian authorities, under the clauses of the Public Health Act relating to union of districts.

Foremost still amongst the difficulties of sanitary administration, is the ever troublesome question of the ventilation of sewers. This matter so closely affects the comfort of the people, that I feel I may be excused for again referring to a question which has been so often discussed by the Members of this Association. Pamphlets and reports by the hundred have been written thereon, there has been abundant controversy, and yet we have advanced but little beyond the primitive methods of discharging the foul gases generated in the sewers by the open grids level with the surface of roadways. Numerous patents have been launched forth for the combustion or disinfection of the gases, but hitherto with no material result. Like many other patents, experiments upon a small scale were eminently satisfactory, which failed from various causes when applied to a comprehensive system extended over a large district.

In many towns the open grids have been augmented by the fixture of upcast iron shafts attached to houses and elsewhere, by which all odours offensive to the olfactory nerves are removed far above their sensitive action. The method adopted is a simple and inexpensive one, and although the efficacy of the shafts is by no means universally agreed upon, my own experience of the system, I must admit, has been most satisfactory. The complaints formerly made by residents have practically ceased in those districts where a perfect system has been available, and the life of the engineer has consequently been a more agreeable one during the summer months than was formerly the case. Doubtless the success of the system largely depends upon local conditions, and the position in which the shafts may be fixed. Some difficulty may also be experienced in obtaining the assent of all persons interested in the fixing of the shafts, but the promise to close the offending grid or grids near to the premises often secures the necessary permission.

The action of these shafts is doubtless largely affected by climatic influences, a greater current being registered during strong winds; but, after a series of anemometrical readings for twelve months, I have found in no single instance a downward current apparent, whilst the upward current has averaged 30 cubic feet per minute, and has upon many days during the summer months, when the utility of the shafts is most required, amounted to 70 or 80 cubic feet. With a current of this rapidity, much more success has been achieved in clearing the sewers of foul gases than would have been possible with the open grids.

The necessity for these shafts as vents for the gases generated in the main sewers of a town would not, however, be so apparent were all the minor tributaries of a system of main sewerage laid with the same care as the public sewers under the control of the local authority. Given a carefully designed and constructed system of sewerage, it is only with the subsidence of flow in the sewers that objectionable gases will be generated, as no stagnation with putrefaction following should exist in the invert of the sewer. The main cause of the odours in sewers, so much complained of, is in my opinion the foul contribution from faulty house drains, where the flushing administered by the occupiers is not sufficient to cleanse the drain and the intercepting syphon from deposit. A systematic and efficient system of flushing to the house drains, where necessary, is therefore an important factor in dealing with the ventilation of sewers, as by this work the possibility of the generation of foul gases is minimised by the sewers receiving a flow free from putrefaction.

The flushing of the sewer itself is at times useless, as the malodorous contributions of the house drains are left untouched, and the sewer itself may have been perfectly free from deposit prior to the application of flushing. The efficacy of this system of flushing to house drains as connected with nuisance arising from ventilators I have practically tested in my own district, by meter barrow and special hose attached to water mains, and have found the results to be favourable in every way.

It is with bated breath that one dares to suggest the abolition of the syphons attached to the house drains, those miniature cesspools through whose putrefying media all drains must now discharge. Whilst at times they are useless for the purpose for which they are fixed, I am confident that at all times they are the source of emanations from house drains. On the other hand, without them, what multiplication to the area of ventilation would be accorded by the thousands of upcast shafts attached to the rear of the houses; and, at the same time, the atmospheric dilution of the sewer gases would be materially increased.

The question of the maintenance of highways, although prosaic in character, is one that more closely affects the everyday life of the public than perhaps many other municipal works of a more apparently ingenious nature. During the middle ages, and until well into the present century, the greater part of the highways in town and country were much neglected, and it is only quite within comparatively recent years that the subject of formation and repair of all roads and footpaths has been more scientifically and intelligently administered, both in the counties and boroughs of the kingdom. It is not much more than a century since Palmer started the first mail coach, the "Tally Ho," which ran from London to Bristol. Before that time the mails were carried by post-boys, and were continually being carried off by highwaymen. The mail coach certainly afforded greater—though by no means complete—security. But this change made men look to their ways, and thus the main roads began to receive more attention; and in connection with this work we remember the honoured names of Metcalf, Telford and Macadam. The improvement effected in the main roads during the past twenty years, however, is due in a great measure to the higher standard of excellence demanded by the county authorities under the Highways and Locomotives Amendment Act, 1878, and the Local Government Act, 1888, prior to any contribution being made towards the repair of these roads; and in this respect doubtless the public have benefited in the matter of comfort, but somewhat suffered in the pocket, by reason of the action thus taken by the county authorities. Another improving aspirant has however, lately appeared upon the scene in the shape of the ubiquitous cyclist. The surface of a macadamised road that was considered satisfactory for ordinary vehicular traffic now proves utterly unfit for the pneumatic tyred bicycle, and I believe it has been seriously contemplated in some localities, where pleasure is perhaps more rampant than in others, that an especially prepared track upon the public highway should be reserved for the cyclist. This may or may not be a necessity of the times, but should it be so, by all principles of equity let bicycles be taxed.

Upon the merits of flint, slag, macadam, asphalt, brick, stone paving, and hard and soft timber, as materials for road repair, I do not propose to dwell, as it quite without the scope of this address, and is a question that has received, and will in the future still further receive, detailed consideration by paper and discussion in the District Meetings to be convened.

Upon one point, however, it appears that but little controversy is likely to ensue, and that is the substitution of wood paving of some description for the stone paving in all residential localities, where the noiselessness of the former material is of necessity in these neurotic days. Upon macadamised roads undergoing excessive wear and tear, with the inconvenience of continuous repair, wood paving has been vastly extended during recent years, and has proved a measure of economy as well as comfort. The comparative advantages of hard and soft woods have respectively their advocates among men eminently fitted to judge, and it is possible that the battle of the timbers has yet to be fought out, not only upon the matter of durability, but also upon the important questions of noiselessness, liability to contraction and expansion, and antiseptic qualities.

The ever popular microbe has also now appeared upon the scene with regard to this particular form of paving, and an entirely new genus of bacteria alleged to be injurious to human organism has been recently discovered as emanating from imperfectly cleansed wood-paved roadways. Unlike the septic tank or the aerobic microbe of the filter, these are of no advantage to humanity and must be exterminated. Thus the necessity for constantly and efficiently cleansing the streets is intensified by this new discovery, and the use of disinfectants in combination with the watering of streets may become much more general.

A novel feature as affecting our highways has been recently introduced by the adoption of the Light Railways Act, 1896, by which powers are given for the construction of railways alongside or over public roads, ostensibly for facilitating the carriage of agricultural produce. During the present year of Parliament, however, these railways have been promulgated in more densely populated quarters than it appears to many was contemplated by the promoters of the Act, and that what was intended as assistance to the farming interest is now developing into the acquisition of tramway facilities, without compliance with the requirements of the Tramway Acts. It is an important question, closely affecting the suburbs of large towns, where these light railways may be introduced without the statutory consent of the road authority, and without any provision as to rate of speed, protection of public roads, restoration and maintenance of the same, purchase of undertaking by local authority, and many other covenants now required by the Acts relating to the construction of tramways. The procedure for promotion is also totally distinct from that of tramway construction, although the work proposed to be carried out may be *de facto* the same. Should these promotions undertake the work hitherto associated with tramways, every endeavour should be made to secure similar protection to local authorities as that provided in the Tramway Acts.

The supervision of new buildings is possibly one of the most important of the duties of the municipal engineer in securing stability of buildings, and in endeavouring to maintain health and ward off disease in the homes of the people. Provision is also made in the bye-laws for the prevention from fire in all new buildings, and upon this matter it does appear that some additions are required in the present bye-laws as generally adopted throughout the country, in order that better provision should be made for fire-proof walls and floors in flats or buildings of the tenement class, now being so generally built in large towns. In the Metropolis, powers for prevention of spread of fire in these buildings already exist; but, except in private Acts, there is no authority that I am aware of outside the Metropolis that can enforce this necessary provision, the corridors and staircases in many cases being of timber, thus adding enormously to the risks of the tenants in the upper floors of any high range of buildings. Endeavour should at least be made to secure powers in this direction by the construction of all corridors and staircases with their enclosing walls in incombustible material, and as I believe is universal in Edinburgh, Glasgow and other large Scotch towns. To render the bye-law absolutely satisfactory, fire-proof floors or horizontal party walls should be rendered compulsory, being properly constructed according to a stringent specification embodied in the bye-laws, so as to avoid a calamity similar to the deplorable accident that has recently occurred at Westminster. This case also seems to indicate the necessity of additional supervision as to the construction of floors and interior walls.

The suggestion is possibly a matter that might be reasonably represented to the proper authorities by this Association after careful deliberation.

Upon the sanitary aspect as relating to the supervision of new buildings, too much attention cannot be paid to the efficient construction of the drainage, and the provision of requisite space around our dwellings in order that a free circulation of air may be secured. Upon the former question there is no doubt but that considerable improvement has been effected in recent years, and valuable additions and amendments have been made to the bye-laws in some districts, ensuring additional precautionary measures where drains are laid under houses, and enforcing proper provision for inspection and testing of drains without the inconvenience caused by the disturbing of the ground as is now found necessary in cases of imperfect drainage. The water test as applied to drains, a simple thing in itself, but one largely affecting the efficiency of the house drain and consequently the health of the people, is also now almost universally adopted, although it would possibly be desirable that this description of test should be definitely fixed and ratified by reference in the bye-laws.

The maximum amount of air space as now provided I think will be agreed is little enough, 25 feet of ground being by no means too extensive an area for thorough ventilation in densely inhabited neighbourhoods. Unfortunately, however, many of the smaller houses receive little more than half this extent of land in the rear of the house, so that with a rabbit hutch and a chicken run but little worthy of the name of garden remains. Every endeavour should therefore be made by the municipal engineer to enforce this necessary provision for sanitation to its utmost limits, as the health returns now so clearly point to the excess of sickness in crowded localities.

Of all municipal works at present in progress, and contemplated to a still greater extent in the future, none show more general adoption in all parts of the kingdom than the installation of electric lighting plant, the Provisional Orders applied for during the present session being in excess of any previous year. The almost universal action now taken by local authorities in the installation of electric light themselves, to the exclusion of monopolies, brings the question largely within the scope of the duties of the municipal engineer, the highly trained electrical engineer being an official of the corporation or town together with his colleague the civil engineer and surveyor. In the first stages of the introduction of any scheme of electric lighting the latter officer is often actively engaged, more especially with regard to the sites for central and sub-stations, and the routes for the transmission and distribution of the electrical energy. This must be my excuse for the few remarks I may have to make upon this prominent matter of municipal engineering interest.

The advantages in many ways of electric light over any other form of artificial light must be generally admitted, and the financial success of most undertakings by municipal authorities seems to be fairly assured after the second or third year of working. Thus it is to be anticipated that in the early future this system will, like many other municipal promotions of a similar character, become a relief to the burden of rating, and that the price will compare favourably with that of any other description of lighting. At the outset in any new venture, it is to be expected that the cost of supply to a limited number of customers must be greater in proportion than when the undertaking has been more generally adopted. This was the case in the early stages of gas supply, but nevertheless the better illumination and general superiority of gas was sufficient to practically eliminate the use of oil and candles where gas was available. In the same way, even supposing the cost of electric supply may exceed that of gas during the early years of installation, still its convenience and general utility are such that it cannot fail to become the popular illuminant, and that in the near future.

The steady increase in demand for electric light is abundantly exemplified in the various installations throughout the country, where in so many instances the enlargement of the stations and plant are necessitated within two years or even less from completion of the work. In addition, therefore, to acquiring a site with special facilities for carriage of coal by rail or water, or by both if possible, careful provision should be made by the municipal engineer for enlargement in the future, and the buildings so erected as to admit of the most economical and ready means of adding thereto.

One great difficulty encountered in the general adoption of electric light in a residential neighbourhood, and especially where the property is of a small class character, is the expense incidental to the wiring of premises. Endeavours have been made in several directions to remove the difficulty by instituting what is nominally called the free wiring of premises by companies formed for that purpose. This is a work, however, that would be better taken in hand by the municipal promoters themselves, and it does appear most desirable with this intent that borrowing powers should be accorded to local authorities similar to those now exercised for private improvement work, by which the payment of the cost of the work by the owner or occupier, as the case may be, could be spread over a term of years commensurate with the period of the loan. This would be but little felt by the owners of property, and would, I believe, conduce very largely to the extension of electric lighting in residential property tenanted by the middle and working classes.

The public lighting is at present almost entirely confined to arc lamps upon the main streets, the branch streets still being lighted by gas—an old friend that has stood us in good stead and in which considerable improvement with regard to public lighting has been effected during recent years. The incandescent gas burner for public lighting has been introduced with great effect in some districts where the lamps are not too far apart. With long intervals, however, this description of lighting does not appear to possess the same proportionate penetrating power as the ordinary burner. In my own district, 400 lamps have been fitted experimentally with this description of burner with satisfactory results both as to illumination and annual cost.

The combination of the work incidental to the combustion of house refuse with that appertaining to the generation of electrical energy is a subject that has resulted of late in a large amount of pamphleteering and discussion, and although a matter of supreme interest to municipal engineers, is one upon which I dare not trust myself to enlarge on this occasion. Upon all sides, however, it must be admitted that by judicious design of the combined works in the first instance, the utilisation of the caloric from the refuse furnaces must figure in some proportion as an assistance towards the generation of steam in connection with the electric lighting plant, and that, outside the question of the value of the clinker for municipal work and the destruction of the useless refuse by combustion, every pound of steam thus generated should represent a saving in the expenditure incidental to the electric lighting work. Care, doubtless, should be taken in the disposition of the two departments, isolating them as far as is consistent with convenience and facilities for combined working, as the refuse tip and store with its attendant dust and dirt is not a too desirable neighbour to the engine house of the electric lighting works. That the refuse, however, is generally of value for purposes of combustion there can be no doubt, and that it has for many years past unwisely been treated as a useless waste product in large towns has only recently become apparent.

The combination of other municipal works with an electric light installation is also possible in many ways for motive power, thus utilising the day load which at times may in a measure be running to waste. In a minor degree this power could be most advantageously applied to motor cars or vans for the removal of house refuse, slopping and watering, and other work requiring mechanical power, provision being made for charging stations for this purpose at convenient localities within the area of supply. In this direction I believe considerable economy could be effected in a district with a large amount of cartage work, the cost of which often amounts to one of the heaviest items of administration in municipal work.

A somewhat important question as affecting electric lighting undertakings, is the report of the select committee lately appointed to consider amendments to the Electric Lighting Acts that may be necessary to empower the Board of Trade to grant compulsory powers. Among other items in this report, recommendations are made that compulsory powers should be given to electric lighting undertakers for the compulsory acquisition of land for a generating station outside their area of supply. This doubtless will prove of distinct advantage to those towns where the acquisition of site would involve excessive expenditure, but the advantage to the districts outside the area of supply, and whose streets are to be broken up without any commensurate benefit received, may not be so apparent. The matter is, however, in report stage only, and may hereafter be further heard of.

The law relating to public health, the study of which now forms part of the training of every municipal engineer, has been considerably extended since the original Act was passed in 1875. So numerous have been the subsequent Acts added to the statute book, and so varied the nature of the measures to which they refer, that the time has now arrived when great assistance would be rendered to municipal authorities, less litigation would be involved, and the statutes themselves made much more clear, if the Public Health Act, 1875, and the Acts incorporated therewith were consolidated in one General Act relating to matters connected with public health. In this could be included many useful measures now contained in private Acts, and which the Police and Sanitary Committee, in their report to the House of Commons in 1897, have strongly recommended for inclusion in a public Bill. Opportunity might also be taken to secure desirable amendments to the existing Acts, notably in that ill-conceived clause 19 of the Public Health Acts Amendment Act of 1890, relating to combined drainage, which tends to the relief of owners' responsibilities at the cost of the rates.

Additional powers might likewise be conferred upon local authorities to make bye-laws with regard to other matters than those mentioned in section 157 of the Public Health Act, 1875. In the latter case no authority is given over the question of more complete construction of roadways, the separate system of sewerage for foul and rain waters respectively, internal plastering to houses, plumber's work, water supply (more especially with regard to locality and capacity of cisterns) and other matters upon which it is essential to obtain powers in connection with the healthy development of a town by construction of roads and erection of buildings.

There are also many other desirable amendments which I believe are now among the archives of the Association, and were forwarded to the Local Government Board when I had the honour of presiding over the deliberations of the Parliamentary Committee, but which are of too detailed a character to refer to in this address. During the present session a Bill has been introduced into the House with a similar title to the Public Health Acts Amendment Act of 1890, in which many useful clauses have been introduced from private Acts of recent years. Unfortunately, however, I understand that this Bill has been withdrawn during the past few days. Like many more Amendment Acts, the principle of permissive legislation has been adopted in many cases where compulsory measures would possibly have been more desirable. That some powers to be conferred upon local authorities should be adoptive where the public health or comfort or convenience of the majority are not concerned is readily to be understood, but in all sanitary questions or those relating to salubrious dwellings and convenient means of access thereto by roads or streets, it does seem that uniform legislation throughout the length and breadth of the country is in every way desirable. Being thus uniform it becomes better known by all whom it concerns, and consequently there is not the same opportunity for the plea of ignorance by those who contravene the law, and which is now so constantly the defence where powers are possessed in one district that are wanting perhaps in that immediately adjoining. A clause has been recently introduced into private Acts as well as in the Bill before mentioned, which is of intense importance to municipal engineers throughout the kingdom, but especially to those appointed to districts where a large amount of building development is in progress. I allude to the granting of certificates by the surveyor to the local authority, that prior to occupation of all new houses the premises are in every respect in accordance with the bye-laws and requirements of the district for the time being in force—a most salutary clause, and one that most surveyors would gladly adopt were proper and competent assistance rendered them for the close and constant supervision of buildings to ensure strict adherence to the bye-laws in every particular. But what are the facts of the case? In many instances the surveyor, in addition to the many duties of his department, which necessitate a large amount of time spent in his office upon administrative work, has himself to supervise the erection of new buildings, and that perhaps over a district several square miles in extent with work in all directions. How is it possible under these circumstances for a satisfactory certificate to be granted, and is it fair under these circumstances to free the owner and builder from all liability and practically place the same upon the shoulders of the surveyor and through him on his employers? Should such beneficial legislation for the property owners be enacted, by all means let it be accompanied by powers conferred upon local authorities to charge the owners and builders thus benefited for the supervision of the buildings, by which means a sufficient number of qualified inspectors may be appointed to thoroughly supervise all building operations, and thus to justify the granting of a "bona fide" certificate. The question is of such moment to public authorities and their engineers, that earnest endeavours should be made to obtain general powers throughout the country to charge for supervision, without which the operations of any clause relating to the granting of certificates will be ineffective and result in but little benefit to the public, and an entirely new liability fraught with possible litigation to the certifying authority.

Gentlemen, I am afraid that I have somewhat overtaxed your patience in the few disjointed remarks I have made with regard to the works and duties appertaining to the office of the municipal engineer, but I look to the brotherhood which I know exists in our Association to condone any of my shortcomings. Mutual support was originally, as in most associations of this character, one of the main reasons for its constitution, and I sincerely trust that it may always be to the fore, so that in addition to the spread of professional knowledge we may also be ever ready to assist those of our profession who may at any time be in trouble or in need, thus training the heart as well as the intellect for the welfare of our professional brethren.

THE USE OF TARRED MACADAM IN THE CONSTRUCTION OF ROADWAYS IN URBAN DISTRICTS, AND COMPARATIVE CONSIDERATIONS.

By A. H. CAMPBELL, Assoc. M. Inst. C.E.,
City Surveyor, Canterbury.

The committee of the last International Congress of Hygiene and Demography, held at Buda-Pesth, adopted the following resolution: "That the paving of streets should be smooth, and as far as practicable impervious, to facilitate cleansing, and also to prevent contamination of the subsoil."

With this resolution this Association of Municipal Engineers and Surveyors will no doubt heartily concur. It has served to suggest to the Author a good text in the preparation of his paper.

The text of the resolution comprehends in a sentence all the essentials of a good roadway.

These may be briefly summarised under the following heads:—

(*a*) Durability;
(*b*) The minimum of noise; and
(*c*) The minimum of first cost (consistent with the foregoing).

The attainment of the first of these, viz. *Durability*, is best realised by the adoption of granite setts, as may be witnessed more or less in all large cities, and nowhere to a greater proportionate extent than in the city where the Association is now assembled.

This kind of paving, however, is *not* smooth; it is most noisy, the truism of "empty vehicles (not vessels) making the most sound," receiving abundant illustration on this form of road; further, unless laid on a bed of concrete and jointed in pitch, it is *not* impervious, and the facility of cleansing is much impeded, due to the numerous joints wearing open and rounding off, holding the dirt and dust of roadways. It is moreover costly, probably nearly as costly in construction as wood pavement, and its only claim for use is its *durability*.

Allied to this material for road formation is the use of blue brick setts for carriageways, which are having experimental trials in a few places.

The attainment of the second head, i.e. *minimum of noise*, is best realised by one or other of these descriptions of materials:—

1. Gutta-percha.
2. Compressed asphalte; and concrete macadam.
3. Wood paving.
4. Macadam.

The first named is mentioned only as the ideal of noiselessness, and not as entering into comparison with any of the well known materials of road construction. It is in a very experimental stage as yet, and has hardly come within the scope of practical consideration. It is to be seen in small short sections in Glasgow, and at the entrance to Euston Station, London.

Compressed asphalte, also concrete macadam, is clean, impervious, durable, and saving for the clatter of horses' feet, may be described as comparatively noiseless. Involving, as asphalte does, the underlying bed of concrete, the first cost renders it prohibitory in all save large centres of population. It is moreover slippery and unsuited to inclined roads upon a hill.

Wood paving comes next in the fulfilment of the necessary conditions of the text. It is smooth; is probably the least noisy of any of the descriptions of hard pavement; it is of moderate durability; and if of the hard wood description, practically impervious to moisture. Its first cost, however, and the unreasonably short periods allowed for repayment, render the general adoption of wood pavement in moderately sized towns, or even in the suburban parts of large cities, very unlikely if not prohibitory.

The class of town or urban district to which allusion is made, is that of moderate size and limited financial resource, which are restricted therefore to the use of "Macadam" in the constructions of their highways.

As it is from moderately sized towns or districts that so many Members of this Association come, the consideration of any *improved form of macadam paving* acquires special interest and importance; and there is no improved form of macadam which is so coming to the front, and demanding that attention which its merits unquestionably deserve, as that now going by the name of "*Tarred Macadam.*" That is, a composition of any of the stones, gravel or clinkers commonly used in the making of macadam roads with a mixture of *tar*. It appears a simple enough composition, but its preparation and laying so as to turn out a success, bristle with delicate detail.

When properly made and on roads suited for it, this construction of road complies most nearly—compressed asphalte perhaps excepted—with the conditions laid down in the resolution set forth at the outset of this paper. It is a smooth and noiseless road, it is non-absorbent, it is cleanly in itself and easily kept clean, and its first cost is within the capacity of the most reasonably restricted finance of small towns and districts.

With all the advantages enumerated, it appears remarkable that tarred macadam has not been adopted except as yet on the most limited scale.

It is true that tarred gravel or limestone footpaths have been in use for a great number of years, and have now obtained a deservedly wide adoption, but the extension of this same composition, only of a larger gauge metal, to the construction of roadways has been most limited.

As accounting for this, these reasons may be suggested, viz. the failures which frequently attend a first trial; and uncertainty as to the properties and action of *tar*, and how it will unite with the aggregate which it is designed to incorporate.

The Author can speak from personal experience of its failure and of its success too: failure where success was expected, and success where failure might be anticipated; and this as evidence of the fickle character of the composition.

To its preparation, storage and laying, the Author has had special opportunity of study, the composition, as used by him, being prepared by the workmen in his department.

In tabular form there is here submitted an epitome of particulars of several streets laid by the Author during the past three years.

Besides the foregoing list, a number of lanes in Canterbury have been partially laid with this composition; and at the present time St. Margaret Street, about 700 feet long, with a carriageway of only 12 feet, and in the centre of the city, having heavy vehicular traffic, is in process of laying.

The preparation and laying embrace these details :—

1. The nature of aggregate and its preparation.
2. The tar, its nature and treatment.
3. The mixing of these two together.
4. The storage.
5. The laying down upon the road.
6. The cost.

As regards the nature or description of the aggregate, the Author has tried Kentish rag-stone, surface picked flints, pit gravel, and Guernsey granite.

The stone is prepared for the tar by burning in the open. It is laid out first of all in a flat bed about 12 inches thick, and of rectangular plan; on this is spread a layer of coke and breeze about 3 to 4 inches thick, with a little wood to assist the fire, this is then overlaid so as to form a stack of stone of about 5 feet in height from the ground; meantime, as the last addition of height is made, the fire of wood and coke has been kindled, and the fire is allowed to penetrate the stack. About 1½ chaldrons (54 bushels) of coke are consumed in a stack of 60 cube yards.

As regards the length and size of the stack of stone, this may be made endless by laying out the stack so as to describe a circle, thus following in the process of mixing a circular course, with certain obvious advantages.

Other makers of tarred stone composition in the Author's district, arrange the stack in the form of a *cone*, close it up at the top, fire it in the centre, and allowing the fire to penetrate the mass, leave the stack of stone untouched whilst this process of firing proceeds. This operation may take any time between seven and ten days: the stack is then opened up, and the hot stone applied to the prepared tar.

In either of these methods of firing the stone, a great deal of loss by disintegration occurs; the stone succumbing to the influence of fire, and tending to get reduced to a coarse-grained powder.

Particularly so was this the case with a trial of granite exposed to fire, which quickly produced the condition above described.

For this reason the Author would much prefer the heating

Name of Street.	Width of Carriageway.		Nature of Traffic.	Date when Laid.	Thickness, Aggregate.	Cost per Superficial Yard.	Experience.
	ft.	in.					
Stour Street	8	2	Heavy continuous traffic, three traction trains passing daily.	July 1895.	6 inches Kentish rag.	About 4*s.* 6*d.*	Failure; quite unable to support the constant action of the traction engine traffic.
Turnagain Lane (cul-de-sac)	8	2	Light van traffic ..	November 1895.	4 inches of gravel on the old natural road formation.	3*s.*	Satisfactory.
Orange Street ..	17	0	Medium through traffic, carriers' waggons, carts and tradesmen's vans.	March 1897.	4 inches of gravel underlaid by 3 inches hard broken brick.	4*s.* 6*d.*	Most satisfactory.
King Street	(1) 16 (2) 8	6 2	Ditto	May 1897.	3 inches ditto ..	About 4*s.*	Moderately satisfactory; centre of way along horse track commenced to disintegrate, due to the tar being overboiled, and the material hardening or setting before using.
Guildhall Street ..	15	9	Heavy through traffic, omnibuses and general town traffic.	September 1897.	4 inches ditto ..	4*s.* 6*d.*	Generally satisfactory: superficially softens on parts in sun heat, but otherwise is doing well.

7 pence for the tar
g for interest, &c.
a saving in favour
With respect to the
4s. 6d. per square
ing, which of course
was remade. The
2s. 3d. per square

the better for tar

preparing this
st essential to
is the greatest
tar macadam
at a chemical
nsistency and
on the works
ing through
ed on to the
t is to get a
a good, sound,
a good solid
mised road
a compound
ial design
t and the
length, and
the stones
t depth to
We use
annealed
stone,
money,

Name of Street.	Width of Carriageway.		Nature of Traffic.	Date when Laid.	Thickness, Aggregate.	Cost per Superficial Yard.	Experience.
	ft.	in.					
Stour Street	8	2	Heavy continuous traffic, three traction trains passing daily.	July 1895.	6 inches Kentish rag.	About 4*s.* 6*d.*	Failure; quite unable to support the constant action of the traction engine traffic.
Turnagain Lane (cul-de-sac)	8	2	Light van traffic ..	November 1895.	4 inches of gravel on the old natural road formation.	3*s.*	Satisfactory.
Orange Street ..	17	0	Medium through traffic, carriers' waggons, carts and tradesmen's vans.	March 1897.	4 inches of gravel underlaid by 3 inches hard broken brick.	4*s.* 6*d.*	Most satisfactory.
King Street	(1) 16 (2) 8	6 2	Ditto	May 1897.	3 inches ditto ..	About 4*s.*	Moderately satisfactory; centre of way along horse track commenced to disintegrate, due to the tar being overboiled, and the material hardening or setting before using.
Guildhall Street ..	15	9	Heavy through traffic, omnibuses and general town traffic.	September 1897.	4 inches ditto ..	4*s.* 6*d.*	Generally satisfactory: superficially softens on parts in sun heat, but otherwise is doing well.

of the stone in an oven or kiln; the temperature would be more equable, and the severe firing causing the disintegration described would be avoided.

On the subject of "heating" one or two remarks may be submitted. The Author believes it to be the practice with some makers not to heat the stone at all, but being sure that the stone is dry and free from moisture, apply it in the cold but thoroughly dry state to the prepared tar.

This condition of the stone, in the Author's opinion, resembles the risk attached to laying the tarred mixture in position in cold instead of hot weather. The tar refuses to "work," the temperatures are so unequal, and when the sun (particularly the sun of the sunny South) beats upon such a road it is not improbable but that this defect will discover itself in the liquefied tar bubbling and spewing itself up over the surface.

The proper or at least *best* condition of heating is to be obtained by the kiln, where the heat will be rather of the moderate "*baking*" than of the hot "*roasting*" sort.

The temperature of the stone when the tar is applied, should be such as the palm of the hand can bear with comfort: if too hot, the tar will be destroyed as a cohesive; if too cold the tar will go on too thickly, and under the rays of a hot sun will soften.

The hot stone when ready to be mixed with the prepared tar, is sifted through two gauges, graduated to 1 and to ½ inch, giving three sizes of material, viz.: 1-inch to 2-inch gauge for the body material, ½ to 1-inch gauge for the intermediate or fining coat, and ¼ to ½-inch gauge for the skin or top dressing.

These three sizes are laid in layers as follows, viz.: 3 *to* 4 *inches* thick of the coarse, about ¾ inches thick of the intermediate, and the top dressing in the thinnest layer possible, with a view only to filling all interstices; thereafter a dressing of fine ¼-inch granite or lime-stone siftings is scattered broadcast, and the traffic at once allowed on the road, working this top dressing in and assisting in the consolidation of the road formation.

The weight of the roller employed by the Author is nominally 10 tons, and each of the three layers is rolled separately.

Considerable importance is attached to the state of the weather at the time of laying, in the sun by preference and to assure a good result; if laid in a cold temperature and with any defects present in the composition, disappointment and possible failure will result. Weather being normal, any time between *May and September* (inclusive) may be regarded as suitable.

One word as to wet weather; operations both of mixing and of laying should be suspended in time of "wet," where conducted in the open, as nothing so corrupts the composition as the presence of moisture.

In constructing a road of this tarred composition, the old surface is removed to a depth of 8 inches, and re-made with a 4-inch thickness of dry hard broken stone, furnace clinker or brick; this is rolled smooth and finished to the required camber of the road. The Author's reasons for this underlying ballasting of dry material are twofold: (1) to separate the tarred composition from any damp substratum; and (2) to economise in the thickness of tarred material.

Under the Author's practice, the tarred composition is only 4 inches thick (finished). This by itself would be an insufficient surface formation to bear the traffic and resist the damp, but underlaid by the dry ballasting of hard material, well rolled and preferably grouted with cement or brushed with well boiled tar, appears to answer the requirements for which it is introduced.

One sentence is necessary as to having the tarred mixture all in a fresh or "live" state when being laid, otherwise cracking and disintegration of the road will rapidly occur; also in keeping off all traffic during the progress of the work, not because the traffic in itself is an injury, but because of the dirt, dust and other matter foreign to the mixture being imported, and destroying the binding together of the layers in one corporate mass. This hint is one to which the Author attaches considerable importance, as the effects of this occurrence have been painfully present to his sight upon portions of two roads which he has laid down.

TAR.

The quality of the tar employed is no less important than the other details of the work.

Some trading firms making this material use the refined or distilled tar, and excellent results are thus obtainable; but more commonly it is the ordinary gas tar that is used at a cost of about 2*d.* per gallon. This tar should be as far as possible free from water, of a stiff dense consistency, any defects of this character having to be counteracted in the boiling operation; the lighter the tar the longer it must boil, so that all light oils are driven off.

The following pertinent observations on the subject of coal tar have been submitted by the Author's friend and colleague (Mr. Sidney Harvey, F.I.C., Public Analyst).

"Coal tar is a bye-product of extremely complex constitution, containing matters volatile at various temperatures.

"The effect of heat upon coal tar would be to volatilise certain principles therein, whereby the residue would be more viscid and tenacious than the original substance, while its melting or softening point will be proportionately raised.

"As the ultimate result of the continuous application of heat is *coal tar pitch*, it is desirable when coal tar is used in conjunction with road-making materials, that the heat in question should be applied *long enough* to secure the most tenacious and difficultly fusible product, but *not pushed so far as to bring about a brittle nature to the pitch itself*, which latter would defeat the effect aimed at, which is to agglutinate the fragments of rock material with a water-tight cement, which, while protecting the mineral from 'weathering,' would not yield to the heating action of the sun's rays."

In the Author's practice the tar is boiled in 50-gallon coppers; it is brought to the boil and maintained so for a period varying from three to four hours; with good conditioned tar three hours' boiling is amply sufficient.

To each 50 gallons of tar is added a small proportion of pitch (about half a bucketful), and these are boiled together.

The Author would not assert the necessity of introducing even this small proportion of pitch, but the cost is almost infinitesimal, and as a counteractive to bad quality of tar it is good and worth introducing.

The quantity of *tar* employed appears to vary with different makers, just as much as do the other details of this interesting work. It also varies with the season and with the consideration whether, when mixed, the material is to be at once laid or is to be stored in a heap.

If the weather is cold and if the material is to be stored, the less should be the quantity of tar used.

Weather being hot, and material being laid down at once, a slightly greater proportion of tar may be used than under the reverse conditions.

At the present season, with the material being laid soon after mixing, although a brief storage is found necessary, the following are the quantities of tar that are used, viz.—

	Gallons per cubic yard.
With the coarse (1-inch to 2-inch gauge) material	8
With intermediate (½-inch to 1-inch gauge) material	10
With fine sifted stone (½-inch gauge) material	12

From a return supplied to me by the foreman of works, the Author submits the following statement giving the detail cost of the material.

The stack of stone operated on for test contained 45 cubic yards; and the actual cost in preparing that quantity is:

Debit.

	£	s.	d.
45 cubic yards pit gravel at 8s. 6d.	7	17	6
79 gallons tar, and cartage, at 2½d. per gallon	0	16	5½
234 lbs. of pitch at 46s. 8d. per ton	0	4	10½
84 bushels of coke* at 9s. 4d. per chaldron	1	1	9⅓
80 „ breeze	0	8	0
Wages in preparing and mixing stone and tar	7	18	7
	£18	7	2⅓

* Includes the coke consumed in the tar boiler.

Credit.

Actual product from the foregoing:

40 cubic yards of mixture costing £18 7s. 2⅓d., equal to 9s. 2d. per cubic yard.

This composition, as above described, laid 4 to 4½ inches thick, finished in compressed condition, will work out at fully 1s. 6d. per super. yard for the mixture alone.

	s.	d.	
To this	1	6	per super. yard.
Add these items (estimated):—			
1. Stripping road 8 inches thick	0	9	„ „
2. Broken brick ballasting	0	10	„ „
3. Applying the tarred material in three layers and finishing off	0	9	„ „
4. Rolling road	0	3	„ „
5. Add contingencies 10 per cent. ..	0	5	„ „
Total	4	6	per super. yard.

The life of this description of road paving may be taken at seven years; so that divided up over that term, the annual cost of a road so paved will work out at 7·7*d.* During this term it may become necessary to outlay certain small amounts in repairs so as to maintain the surface smooth, whole and impervious; this, estimated at 2*d.* per yard per annum, will give a grand total of 9·7*d.* per super. yard per annum for this description of roadway.

This rate for a good street pavement in urban districts, for heavy vehicular traffic of the ordinary sort (that is excluding traction engine traffic, for which it is unsuited), is most moderate.

Compare it with any of the other descriptions of paving: even than ordinary macadam it is rather *less*; and side by side with any of the improved harder pavements, *wood*, compressed asphalte, or *setts* on concrete bed, it is incomparably less costly.

The Author does not, however, suggest that this description of pavement should enter into competition with these superior materials of road construction; each and all of them—stone setts, wood, asphalte, tarred macadam and ordinary macadam—have their respective places; all, save tar macadam, have had their field and play, and it is for a fair field, devoid of any favour, that the Author presents to the Association a plea on behalf of tar macadam.

On the leading streets of smaller provincial towns, in the secondary and suburban thoroughfares of large towns, where in many cases stone or granite setts are used, of heavy cost, tarred macadam properly prepared and laid would form a welcome, valuable and economic substitute.

DISCUSSION.

Mr. Smith-Saville: I should like to propose a vote of thanks to Mr. Campbell for a paper which I am sure will be of great interest and value to the Association. In the town which I represent, we are very anxious to reduce the noise on the roads round the parks, and there I propose the use of macadam as quieter than the ordinary grit or granite paving used throughout the town. Some years ago I had a good deal to do with tar macadam, and then it was our practice to mix the tar with cold stone without any heating, and then when the roadway was covered with tar macadam, we put on some limestone chippings and rolled it well into the surface. I consider it a somewhat slippery pavement, and on that account should like to ask Mr. Campbell what is the maximum gradient on which it can be used with safety, as the roads I am considering are rather steep, and with ordinary macadam I am rather afraid of the excessive wet which we have washing away the binding material.

Mr. C. F. WIKE: I have followed the paper with very great interest, as during the last ten years I have laid about 8 miles of roadway and 150 miles of footpath with this paving. First, with respect to the drying of the material for the tar macadam, in Sheffield we use flues covered with iron plates, and this system is I believe adopted generally in the Midlands. A great deal of time is thus saved, as the material can be dried evenly and used within twenty-four hours, though it is desirable to leave it for a longer period. The system described by Mr. Campbell would, I am afraid, result in the calcining of a portion of the material. I have tried different materials for tar macadam, including granite, limestone and furnace slag. Granite has not been very satisfactory as it is non-absorbent, and consequently the material does not bind, but in time becomes dry and loose. Limestone and furnace slag (not clinker, as we understand the term in Sheffield) make much better work, as they absorb tar and bind together better. With respect to the life of tar macadam, which the Author has given as seven years, I have had several streets laid with this material kept under observation, and find the life and cost vary very much according to the amount of traffic, the locality, the gradient and the proximity of trees. The cost has been in one case 4*d.* per square yard per annum, in others 7½*d.*, 2½*d.*, 2*d.*, 9*d.*, and 7⅝*d.*, per square yard. The life of these streets has varied from three to ten years, including slight repairs. I have also had comparisons got out of the cost of tar macadam and granite in a street which had been laid with the former material nearly twenty years, in which period the tar macadam had been twice entirely relaid in addition to smaller repairs. The estimated cost of granite paving in a street with similar traffic came out at 102 pence per square yard, as against an actual cost of 157 pence for the tar macadam for the twenty years, allowing for interest, &c. Therefore, on twenty years' wear there is a saving in favour of granite of as much as 50 per cent. With respect to the cost per yard, I think the Author in taking 4*s.* 6*d.* per square yard has included the foundation and stripping, which of course would not be necessary every time the road was remade. The tar macadam alone in Sheffield costs us about 2*s.* 3*d.* per square yard for roadways, and 1*s.* 6*d.* for footpaths.

Mr. CAMPBELL: Quite right, so much the better for tar macadam.

Mr. F. BAKER: One of the chief points in preparing this material is the boiling of the tar, as it is most essential to get all the tar of the same consistency; that is the greatest difficulty one has to contend with in making tar macadam roads. I am able to get the tar boiled for me at a chemical works, so that we always get it of the same consistency and in any quantity required; it is delivered from the works through cast-iron pipes with a steam pipe running through the centre; it is always kept very hot, and delivered on to the stones as we require it. Another essential point is to get a good foundation for the road. You cannot make a good, sound, tar macadam road unless you have under it a good solid foundation. In working on an ordinary macadamised road our method of procedure is as follows. We have a compound traction engine, which was made to my own special design and a Jackson's scarifier. The engine is sent out and the macadam ploughed up with the scarifier a certain length, and then the stone is screened and the dirt removed, and the stones raked over to a proper level. If there is sufficient depth to allow of it, I fill it up with ordinary untarred stone. We use two kinds of material in Middlesbrough, the broken annealed scoria, which costs 3*s.* per ton, delivered, and the whinstone, which costs 7*s.* 6*d.* per ton delivered. Of course, the scoria is not equal to whinstone, but it is less than half the money, and I find it a very satisfactory material and certainly very good for filling-up purposes. One other point, as to heating the stone. I do not think the heating of the stone is necessary, provided the material is perfectly dry. The main secret of the whole success in making the tar macadam is to have it of the right consistency and properly boiled. I have made splendid roads in Middlesbrough in that way. It is important to keep the traffic off the road while it is being made and for a few days afterwards, to allow it to properly set; keep the roller on continuously and consolidate. I have an ordinary horse roller which is in the first case rolled constantly on it, then afterwards the steam roller is put on, as my experience is that if you put a 15-ton roller on to the loose tar macadam it pushes it up in a wave in front of the wheels, and that is the reason why I use the horse roller first. Of course the cost of the material varies in every place, and therefore I do not think the figures given by the Author are of much practical value, as the cost of the road must depend upon the price of the material in the district. I have put down many thousands of yards at 1*s.* 6*d.* per square yard, laid complete and rolled. I am speaking now of tar macadam laid on an old macadam road, and not of the cost of making an entirely new road. Many Members of the Association will remember that at a District Meeting held at Scarborough some seven years ago (vol. xviii. p. 236), we had a paper on this very subject of tar macadam. I know that in Scarborough they have a very long and satisfactory experience of this material, and that they have miles of roadway laid with it. There they burn the stone by placing it in heaps about a yard thick, and placing coke and wood on the top and then firing it, using the tar cold. In my experience, however, I find that the great thing is to have the tar properly boiled so as to eliminate the oils and water from it, and ensure its being of the same consistency throughout, which is a very difficult thing to do with small boilers.

Mr. J. Lemon: I will not detain you more than a few minutes. There is no doubt that the cyclist has much to do with the improvement of our public highways. The members of my Works Committee have taken to riding bicycles, and they have since made a great many complaints about the condition of the roads. Our Surveyor of Highways thought those complaints were very unreasonable; but the members of the Committee were equal to the occasion, and they have bought the surveyor a bicycle. Since the surveyor has taken to riding a bicycle he has come to the conclusion that the roads he previously thought excellent are rather bumpy, and he has gone in strongly for tar macadam. I think there is a future for tar macadam, particularly if it is properly made. But there is nothing particularly new about this kind of roadway. I have seen it in various towns, and have seen a good many failures. There is no man who, perhaps, has had more experience than Mr. Wike, of Sheffield, and he will bear out what I say, that everything depends upon the way in which the material is prepared. I think it is a mistake to put tar macadam on new roads. I think tar macadam can be used with more advantage upon old macadamised roads—roads which are now a failure as regards their maintenance. There is this about it, that on such roads you do not require the very costly foundation which has been referred to by the Author of the paper. I daresay it is the experience of many of you who have a macadamised road about which complaints are made, that if you take that off and put on tar macadam you do not want the foundation which has been referred to, but can do it at much less cost. You can break up the old material, and put on a good tar macadam for 3s. per yard super. If you do that you are making a great improvement at small cost. I would, however, throw out a word of warning. If you have not had much experience of this material you had much better put the work in the hands of a company or some one who has had experience of it, as so much depends upon knowledge of it as to whether it is a success or not. There is a great deal to learn about tar macadam, although it may appear to be a simple thing. The quality of the tar varies considerably even from the same gas-works, and there are many other details about it, the attention to which make for success or failure. If you go in for tar macadam you should endeavour to make it a success from the start.

The **President**: There is one matter which occurred to me in Mr. Wike's remarks. Mr. Wike spoke about certain tests, and some financial statements relative to the wear and cost of tar macadam. It would be as well if Mr. Wike would let the Secretary have those tables which he referred to for the Proceedings of the Association, as they would form a useful addition to the discussion on the paper.

On the formal proposition of the President, seconded by Mr. Smith-Saville, Darwen, a hearty vote of thanks was given to Mr. Campbell for his paper.

EXPERIENCE OF EDINBURGH WITH REFUSE DESTRUCTORS.

By JOHN YOUNG, C.E., Edinburgh.

Mode of Collection of Edinburgh Refuse.

The population of the City of Edinburgh, with its extended boundaries and Portobello, is now 292,364, having an area of 8804·38 acres. The number of inhabited houses is about 61,622. Under the Edinburgh Municipal Acts, penalties are enacted on "any person who accumulates within any enclosure, area, house, building, garret, cellar, or other apartment any dung, soil, dirt, ashes, filth, or other offensive matter or thing." The ashpit system is practically unknown here, and as the whole city is under the water-carriage system of sewage removal, and water-closets almost universal, very little fæcal matter finds its way into the refuse, which is consequently of poor manurial value to the farmer. The whole refuse becomes the property of the city, and the inhabitants are fairly regular in putting it out of their premises for removal. This they do in wooden buckets or iron receptacles, placed at the street kerb at night or early in the morning, but they must not empty their refuse on the street, or allow it to blow about, or they are subject to a penalty. This is, however, a difficult matter to regulate. It is found that a large proportion is, however, emptied on the streets, and the buckets are overturned by people who make a living by picking out materials which can be sold.

The refuse carts and waggons make a daily round of the whole streets of the city in the early morning, and collect all the refuse put out, together with the street sweepings which the scavengers have collected on their various beats. The carts and waggons are covered over on the top to prevent the refuse being blown about while in transit to the depôts or destructors. The carts have a capacity of about 73 cubic feet, with a weight of refuse carried of from 10 cwt. to 18 cwt., and the four-wheeled waggons a capacity of about 108 cubic feet, with a weight of refuse of from 15 cwt. to 23 cwt. The total amount of all kinds of house, shop, market, trade, and slaughter-house refuse, street sweepings, slurry, road mud, and the heterogeneous compound known as police manure, collected in Edinburgh in one year is about 140,000 tons, made up as follows:—

100,000	tons of general city refuse.
40,000	tons of mud and street sweepings.
140,000	

There are two tooms for street sweepings, road mud, &c., one being at Queensferry Road and the other at Powderhall.

The refuse, which is despatched by railway to the country, is sent from the loading banks at Logie Green, Dundee Terrace, St. Leonard's and Meadowbank. A portion is also sent by canal-barge from Fountainbridge, and carted out of the city to an old quarry at Redhall. The principal tip in the country is at Clapperton Hall, twelve miles distant from Edinburgh to the west, where large natural hollows are being filled up. The portion of the Edinburgh refuse sent to the destructor is collected from that district of the city north of Queen Street, and amounts to nearly one-fourth of the total amount of refuse collected in Edinburgh. The area of the district is approximated in the different seasons, so as to yield as much refuse as the destructor will consume.

The quality of Edinburgh refuse sent to the destructor is very mixed, light in weight, bulky in measurement, very dry, and possessing a poor amount of cinders and carbonaceous substances, but contains a large amount of dusty and sandy matter. This is partly accounted for by the daily collection, the high burning qualities of the coal used in the district, the habits of the citizens, the state of the weather, and the admixture of street sweepings, which inevitably get mixed up in lifting refuse off the streets. From the following table a comparison may be drawn with ashbin refuse as collected in London, and given in a report on "Dust Destructors," by the Medical Officer and Engineer of the London County Council in 1893, viz.:—

	London "Ashbin" Refuse.	Average Edinburgh Refuse.
Breeze, cinders and ashes	64 per cent.	25·5 per cent.
Fine dust	19 "	37·0 "
Paper, straw, organic matter, bottles, bones, tins, crockery, &c.	17 "	37·5 "
	100	100

In regard to its bulky character it is found by measurement that there are about 80 cubic feet to 1 ton, whereas it is said that there are only 40 cubic feet per ton in the ashbin refuse of English towns.

The former mode of disposal of the city refuse was by despatching to farmers as much as they could take, the surplus being carted and tipped in waste hollows, ravines, and old quarries at Powderhall, Liberton Dams, and Redhall Quarries.

RAPID DECLINE IN DEMAND BY FARMERS.

For the ten years from 1870 to 1880, the average amount of street refuse sold to farmers was 56,030 tons, and the average rate per ton obtained 2*s.* 0·203*d.* For the ten years from 1880 to 1890 the average amount sold was 63,827 tons, the average rate per ton being only 7·404*d.* The price per ton obtained for the refuse in 1870 was 2*s.* 9·661*d.*, but this had fallen in 1890 to 3·477*d.*, and ultimately to nothing. The annual average revenue had decreased from 5650*l.* to 1969*l.*, showing a falling away of 3681*l.* per year. The Cleaning Committee in the end of 1890 were thus brought face to face with an ever-decreasing demand for the refuse by farmers, and consequently a great drop in the revenue, the difficulties of finding suitable tips for the refuse, a marked diminution in its quality and manurial value, together with a considerable increase in the quantity of the refuse to be disposed of.

APPOINTMENT OF COMMITTEE OF INVESTIGATION IN 1890. THE REPORT OF SAID COMMITTEE.

The Town Council on 11th August, 1890, adopted a motion by Councillor Sloan, "Remitting to the Cleaning and Lighting Committee with powers to make further inquiry as to the best mode of disposal of the town's refuse." In due course a sub-committee was appointed which visited between 15th and 22nd September, 1890, the towns of Newcastle-on-Tyne, York, Leeds, Bradford, Manchester, Birmingham and London, with the view of studying on the spot the methods of refuse disposal, and generally to ascertain the best scientific methods in operation, so as to find as satisfactory and as permanent a solution as possible. After reviewing the situation of the refuse disposal question and the fall in the revenues derived therefrom, the report goes on to give important statistical and other information bearing on the then current methods of refuse disposal as carried out by English corporations. Very close attention was given in the report to the question of disposal by destructors, and a large number of these were visited and described. The conclusions arrived at in the report were as follows. That the question of diminshed value and falling revenues in connection with the waste matters was neither so urgent nor important a matter as getting rid of them at all. That the English towns were more or less adopting the burning process, and the working of destructors was yielding satisfaction as regards sanitary and economic considerations. That the clinker and residual products are free of smells and innocuous, and can be used for filling up hollows for conversion into building sites and other lucrative purposes. That the time had now come for Edinburgh to deal with its refuse by means of destructors, as the mode of disposing of the city refuse was a failure. That there need be no apprehension on the part of the public as to nuisance or inconvenience arising therefrom. That with the adoption of destructors a real attempt could be made to classify the city's refuse into two distinct kinds, that these should be collected separately, that portion having no manurial value being sent to destructors. That as the city had an area of nine square miles, three or four divisions should be formed, each with provision for dealing with its own refuse. This report of the sub-committee was submitted to the Cleaning and Lighting Committee on 30th January, 1891, and it was presented to the Town Council on 17th February, 1891. The Council approved generally of the report, and recommitted to the Cleaning and Lighting Committee to bring up specific recommendations, and estimates for giving effect to the same. This was approved of on a division on the minutes on 3rd March, 1891. On 28th July, 1891, the Cleaning and Lighting Committee presented an interim report to the town council on the question of the disposal of city refuse, and submitted for general approval plans prepared by Mr. Cooper, Burgh Engineer, of a destructor, and other necessary buildings for one district of the city, viz. the Northern; the site which the committee had fixed upon at Powderhall being the most eligible in their opinion. The probable cost of the destructor was estimated at 3000*l.*, and the buildings, &c., at 9000*l.* The committee asked power to obtain estimates and have the work started forthwith. In the report of the Burgh Dngineer on the plans of the proposed Powderhall destructor, Mr. Cooper also recommended the dividing of the city into four districts, each district having a full equipment of destructor arrangements, with stabling and other accessories for the carting department, entailing a capital outlay of from 50,000*l.* to 60,000*l.* After mature consideration the Town Council, on 8th September, 1891, approved of the proposal to erect a destructor at Powderhall.

ERECTION OF DESTRUCTOR AT POWDERHALL.

In pursuance of the Town Council's instructions working plans were prepared by Mr. Cooper, Burgh Engineer, for a branch cleansing depôt with destructor at Powderhall. Stabling and cart sheds were provided for twenty horses; with overseer's house. Accommodation was also provided in a separate suite of buildings for a refuse destructor of 10 cells, fume-cremators, boiler and flues, chimney shaft, roadways, weighing office, &c. The site of the works (about 1 acre in extent) belonged to the corporation, and was originally a sand quarry which had been filled up with city refuse for some time. It was conveniently situated for the district, and allowed of all the cartage being downhill. The levels of the ground were very suitable, and allowed of the refuse being brought to the tipping or charging house at the level of the adjoining thoroughfare, with the clinkering floor on the next level some 15 feet below, and the lowest level permitted of tipping the clinker and residue from a height of about 14 feet. The whole buildings were substantially built with stone in an ornate character, so as to obviate any unsightliness, and in a measure to disguise, as far as possible, their purpose. The ten cells of the destructor occupied the basement of the large building in the centre, with the tipping platform and charging floor on the floor above. The fume cremators, boiler and flues, and engine and dynamo room adjoined on the basement level. The buildings entirely enclosed the whole plant, and it was the intention from the first to conduct all the operations of disposing of the refuse within closed doors. The buildings were ventilated by a fan with air ducts to the various apartments, the foul air being conducted to ducts discharging into the ashpits of the cells. The whole buildings of the destructor installation, and the stabling, &c., were lighted by electricity generated on the premises. The fires were lighted in the cells of the destructor on 14th August, 1893, and preliminary firing and seasoning of the brickwork of the destructor, flues and chimney went on until the 11th September, 1893, when the works were formally opened by Lord Provost Sir James Russell and Councillors. The works, including building and destructor plant and machinery, were finished in eighteen months, and the cost was :—

	£
For buildings and other works	14,216
For destructor plant and machinery	3,866
Total	£18,082

It was resolved to take specific offers and plans from two of the best known firms of contractors for destructor plant, and Messrs. Manlove, Alliott and Co., and Messrs. Goddard, Massey and Warner, both of Nottingham, were invited to tender. It was found that Messrs. Manlove, Alliott and Co. had erected over 400 cells up to this time, and apparently were the leading firm, and had the largest experience in the matter. The Committee recommended the acceptance of their tender, notwithstanding that it was the higher of the two submitted. The legal contract entered into with Messrs. Manlove, Alliott and Co. provided that they were to erect and maintain for one year a 10-celled refuse destructor plant, machinery and other appliances, at Powderhall, capable of each cell burning 8 tons per 24 hours, of the ordinary house refuse collected in Edinburgh. That the refuse so treated would be reduced in bulk to one-fourth of the original quantity, that the apparatus would effectually intercept all dust and consume all fumes, render these innocuous, and cause no nuisance. The contractors were bound to exercise their best skill as specialists, so as to ensure the best results, to instruct the workmen in the process of burning. In default, they were to forfeit the sum of 500*l.*, which was the penalty attached for any failure of their destructor appliances.

FRYER'S DESTRUCTOR OF 10 CELLS.

This 10-cell destructor was built by Messrs. Manlove, Alliott and Co., of Nottingham, in the summer of 1893. It was of the back to back type, with five cells on each side, and formed a block of brickwork 36 feet by 24 feet by 12 feet high. Each cell had a capacity of 126 cubic feet, with a firegrate area of 25 square feet, a drying hearth behind this of 22 square feet area, covered over with a sloping reverberatory arch.

The cell possessed two new features over those previously erected, which were claimed as improvements at the time. *First.* Instead of the back wall of the cell being taken up with the charging hopper on one side, and the exit opening to the main flue on the other, this wall was divided into two openings in connection with two down-take flues from the cell into the main flue. These openings were provided with flap doors, arranged so that by opening the front clinkering door of the cell the two back doors of the flues were closed all but an inch. It was hoped by this arrangement to prevent an inrush of cold air into the main flue when the clinkering door was opened. These flap doors were continually giving trouble by buckling up and refusing to work, so much so that they had to be done away with entirely. The *second* point of difference in this cell was the charging door which was placed in the middle of the reverberatory arch, and was closed over with an iron sliding plate cover. This cover and its frame were also so affected by the heat that it frequently became red hot, and got distorted to such an extent that they would not cover the opening effectually. Many different expedients were tried without success to protect this door from the heat, but all these failed, with the result that the refuse lying on the top deck of the destructor smouldered and took fire, emitting very unpleasant smells in the charging house. It was quite evident that the position of this charging door was badly placed, being almost immediately over the hottest part of the fire. Another cause of nuisance from bad smell in the charging house was the extreme heat developed in the deck top of the destructor, which had the effect of communicating to the refuse lying thereon too much heat, and to such an extent, that "cooking and stewing" of the refuse took place, and consequent nuisance resulted. The cells of this destructor were provided with rocking firebars worked by hand levers from the front. The ashpits were open, and received the discharge from an exhausting fan which was connected to the charging house with the object of sucking away any noxious fumes generated therein.

At the beginning of the work a revolving screen was erected at one end of the charging house. Attempts were made to screen some portion of the refuse, so as to obtain sufficient fuel for four of Jones' Fume Cremators, but the material obtained was both inadequate in quantity and quality for keeping the cremators up to anything like a proper temperature, and had to be dispensed with. Finally, gas breeze and coke had to be purchased, and burned in the cremators. The cost of working the cremators was prohibitive, and quite out of proportion with any beneficial result, either in appreciable rise of temperature or cremation of the gases coming from the destructor. Beyond the cremators, placed side by side, was the bye-pass flue with large damper, and the brick-seating of the multitubular boiler, 12 feet long and 7 feet diameter, with its damper, behind. These both joined together and formed the main flue, 4 feet by 7 feet, which curved round in a quadrant bend to the chimney. In the main flue were placed two wire screens for catching unburnt paper. These were made to slide into an underground pit for cleaning purposes, and answered their purpose very well. The chimney was built for natural draught, being 7 feet 6 inches diameter at the bottom and 6 feet 6 inches diameter at the top, and 185 feet high from ground level. It was provided with an internal lining and air-space all round for a height of 50 feet, and a dust-pit was placed in the bottom. A steam engine and shafting was also provided for driving the dynamo for electric lighting and the ventilating fan; and a mortar-mill is also placed outside for grinding clinker and making mortar, but there is no demand for it in Edinburgh.

As the work of erecting the Fryer's Destructor installation had been carried out under the supervision of Mr. Cooper, Burgh Engineer, the burning of the refuse was also continued under his charge, with the view of ascertaining the capabilities of the destructor, and in order to determine whether the terms of the maker's contract had been fully implemented. Mr.

Cooper reported to the Cleaning and Lighting Committee, in March 1894, the result of the operations at the destructor for the period from 17th January to 24th March, 1894, as follows:—

"1. That the *amount of refuse* burned during the period was at the rate of 64 tons 5¼ cwt. per day of 24 hours (three shifts of labour) for 10 cells.

"2. That the *cost per ton* of refuse burned, including labour, oil, wick, waste, gas cinders, arc lamp carbons, and other sundries, and also taking into account the interest and sinking fund at 5 per cent. on 10,000*l.* expenditure of capital outlay, the *cost per ton of refuse burned worked out at* 1*s.* 4·723*d.*"

Mr. Cooper's report further comments on the nature of the refuse to be burned. "As regards Edinburgh refuse, our experience is that on the whole, owing to the amount of soft ash, road sweepings, and sandy matter it contains, the furnaces are seriously hampered in their work. The first delivery of refuse in the morning, which is almost wholly house refuse, is as a rule of good quality for burning and clinkering. A large part of that delivered in the after part of the day, which is intermixed with road sweepings, is heavily charged with dust and sandy matter, which, as I have said, not only will not burn, but seriously chokes up the furnaces. It has also been found hopeless to obtain material out of the refuse for the cremator fuel. I think that were the same department and officers in charge of the burning who are in charge of the collection of the refuse, experience would speedily dictate the necessity for separating road sweepings, dust, &c., from the refuse delivered at the works, and the result would be a considerable improvement, both in the amount burned and in the nature of the clinker. As might also be expected, a number of improvements for more rapid combustion, for simplifying the labour in charging the furnaces, for fuller utilisation of waste heat, &c., have suggested themselves."

From time to time, as experience was gained, every effort was made to work the destructor up to this guaranteed efficiency, but without successful result.

From several tests the following may be selected as what was accomplished:—

On 4th October, 1893, 45½ tons burned in 16 hours.
„ 24th „ 60½ „ „ 24 „

For the period from 18th January to 24th March, 1894, the average daily burning was at the rate of 64 tons 5½ cwt. per 24 hours.

For the first period, from 14th August, 1893, to 17th April, 1894, under the charge of the burgh engineer, the total amount of refuse burned at the Powderhall destructor was 10,868 tons. The men worked in three shifts of eight hours each, there being one engineer and three furnacemen to each shift for the period from 30th September, 1893, to 31st March, 1894, afterwards one engineer and four furnacemen per shift.

For the period from 18th April, 1894, to January 1895, by order of the Cleaning and Lighting Committee, the destructor was handed over to the responsible officer of the cleaning department, who had full charge of the staff engaged in the collection, delivery, burning and disposal of the refuse and clinker. The quantity of refuse delivered and consumed at the destructor during this period was 12,921 tons, being an average of 61¼ tons for ten cells in the twenty-four hours. The quantity of coke burned in the fume cremators was at the average rate of 2 tons per week.

SHORT HISTORY OF DESTRUCTOR ENDING IN LAW COURTS.

On 12th November, 1894, after the destructor had been working for fourteen months, the Corporation received notice of an action of interdict, at the instance of Alexander's trustees, on behalf of the proprietors of the adjoining property of Redbraes, situated on the opposite side of the North British Railway from the destructor. It was maintained that noxious fumes and gases, and offensive dust and charred paper, were disseminated over the Redbraes property from the destructor premises and the clinker bings, to the discomfort of the pursuers and their tenants, and damage to the trees and shrubs in the nursery grounds, causing them great discomfort and annoyance, and loss, injury and damage, and that the value of the property was being deteriorated. The Corporation resolved to defend the action, and it was tried in the First Division of the Court of Session before Lord Stormouth Darling. The case was before the courts for ten days, between 29th May and 24th July, 1895. There were thirty-four witnesses examined for the pursuers, and twenty-eight for the defenders, and a large mass of very interesting and scientific evidence was given on both sides. The general purpose of the evidence went to prove that the destructor had been imperfectly worked from the beginning; that the temperatures obtained, on the whole, were too low, and the combustion defective for the peculiar nature of the refuse dealt with; that the fume cremators, although regularly in use, were inadequate for the destruction of the fumes, and the system did not sufficiently provide for the interception of the large amount of dust; and that, consequently, nuisance had resulted, and damage been occasioned to the adjoining nursery grounds of Redbraes.

The Lord Ordinary, in his interlocutor and opinion of 31st July, 1895, found that the Corporation had worked the destructor in such a manner as to create a nuisance, but that, as the remedial measures adopted since the raising of the action had to some extent abated the nuisance, it was reasonable that time should be allowed for making further improvements so as to remove, as far as possible, all just cause of complaint. He remitted to Mr. B. Hall Blyth, C.E., Edinburgh, to visit the premises from time to time, and, after conferring with Dr. Odling, Professor of Chemistry at Oxford, to report before the end of the year 1895 what change, if any, either in the apparatus itself or in the mode of working it, was necessary in order to prevent the escape of noxious gases or vapours, and the diffusion of noxious dust and other matters over the pursuers' said property. Finds the pursuers entitled to expenses, &c. Soon after the notice of the action by Alexander's trustees, and pending the beginning of the action and afterwards, the management of the destructor was again placed in the hands of the Burgh Engineer, in January 1885, by the Corporation, and as the consequence of his recommendations a better mode of working was introduced, whereby the cells were charged and clinkered in rotation every two hours. Two experienced foremen were brought from Bradford to superintend and instruct the day and night shifts. Finer screens were put into the main flue to intercept the paper, and proper regulating of the dampers was insisted on. To prevent any nuisance from the watering of the clinker a specially designed box was introduced by Mr. Cooper. This box was strongly made of sheet iron mounted on wheels. It had three sides and hinged top. It was wheeled in front of the ashpit when a fire had to be clinkered, the clinkers were raked out of the cell into the box, the lid was closed, and a hose turned on to the hot clinkers through holes in the side of the box. This entirely prevented any escape of sulphurous fumes into the clinkering house, they being sucked into the ashpit instead. This apparatus worked very well, and anticipated all objections to the watering of the clinker. With the object of increasing the temperature in the cells, one of these was fitted with the steam air blast, and better combustion and clinker was obtained.

On the 23rd December, 1895, Mr. B. H. Blyth and Dr. Odling reported to the Court, after making visits to the Powderhall destructor, from time to time, as well as several destructors in England. In their opinion the nuisance complained of arose from three causes, viz.:—

1. From imperfectly consumed noxious gases, and dust escaping from the chimney.
2. From noxious fumes and dust being blown out of the clinkering chamber.
3. From bad smells given off from the feeding chamber, owing to the refuse waiting for burning heating while lying on the top of the cells.

To obviate these they recommended that several alterations in the apparatus and mode of working be adopted, viz.:—

1. That steam jets be introduced into all the cells to assist combustion and raise temperature in main flue.
2. That the cells be fitted with a front exhaust.
3. That Boulnois and Brodie's charging trucks should be used on the top of the cells to prevent contact of refuse with heated top of destructor.
4. That a large dust chamber be provided in main flue.
5. That the clinker should not be watered, and a cooling platform be formed for laying down the hot clinker outside the building.
6. That more intelligent and experienced stokers should be employed in the working.

By the time the report was published the Corporation, at Mr. Cooper's instigation, had practically anticipated several of the recommendations made in Mr. Hall Blyth's report, notably with regard to the steam jets and the dust-chamber. A complete system of forced blast was applied to the cells of the destructor. This consisted of closing up the fronts of all the ash-pits with brickwork, having doors for the removal of the dust falling through the fire-bars, and the provision of two steam jets with blowing nozzles into each cell. The result was fairly satisfactory at first—a much greater combustion was got in the cells, and better clinker was obtained for a time. The only drawbacks experienced were the choking up of the blowing jets, the unsuitability of the rocking bars for the proper admission and distribution of the forced blast, and the blowing out of the smoke and fumes from the cells, through the badly fitting charging doors at the top. The increased heat obtained was very destructive to the brickwork of the cells, and a larger proportion of dust was deposited in the flues. On the whole, this installation of forced blast rather emphasised than obviated the previous difficulties as to nuisance from dust, and the overheating of the refuse lying on the deck top of the destructor. Any benefit got from the forced blast in increased combustion was neutralised by the very light, sandy and dusty nature of the refuse, the greater portion of which could not be got to clinker in the fires. To prevent the dust escaping up the chimney, a pit was formed in the floor of the main flue near where it joined the chimney, and a water spray introduced for wetting the gases as they passed this point. This apparatus had the effect of arresting a fair quantity of dust and of cooling the gases before they entered the chimney. Under these somewhat improved conditions the burning of refuse was persevered in, and the amount consumed from 15th May, 1895, to 15th May, 1896 = 16,141 tons. The cost had, however, gone up to nearly 2*s.* 1*d.* per ton, including all charges, and this was felt to be excessive, and could not be maintained.

As the recommendations of Mr. Hall Blyth involved considerable expenditure, and were calculated to make such radical changes in the construction of the destructor as regards the fitting up of charging trucks and the front exhaust from the cells, the corporation having met the rest of the proposals made, they lodged objections to these, which were duly answered by the pursuers. The reporter's recommendations being persisted in, the corporation ultimately resolved on the entire reconstruction of the Powderhall destructor on the most modern and approved system.

In August 1896 an estimate was obtained from the Horsfall Refuse Syndicate, Leeds, and a legal contract was entered into on 13th October, 1896, for the remodelling of the Powderhall destructor on their improved system, with all special appliances necessary for the successful disposal of the refuse, to the entire satisfaction of Mr. Hall Blyth, C.E., or such other man of skill as the Court might appoint. The contract provided that each of the cells should consume 8 tons per twenty-four hours of the ordinary Edinburgh refuse, and that the residue would be reduced in bulk to at least one-fourth of its original quantity, and the temperature maintained would be 1800° Fahr. They were also bound to provide all other appliances for satisfying the terms of Mr. Hall Blyth's report to the Court as regards noxious fumes and dust. The work was to be entirely completed in twelve weeks, and maintained for one year after completion. In case of failure of any part of the contract a penalty of 500*l.* was to be imposed. The work was completed in the end of January 1897, and the burning of refuse again commenced under the new conditions, and has been in operation ever since, with the exception of a short period when sundry repairs were found necessary.

RECONSTRUCTION OF FRYER'S DESTRUCTOR BY THE HORSFALL REFUSE SYNDICATE, LIMITED, LEEDS.

Under this scheme of reconstruction the whole of the old destructor cells were taken down to the under side of the fire-grate level, and ten entirely new cells built on the old foundations by the Horsfall Refuse Syndicate, Leeds. The new destructor is much the same in outward appearance and size as the old Fryer's destructor, but has many new features, and special arrangements were adopted to meet the conditions imposed under the contract. The new Horsfall cell has a capacity of 165 cubic feet. The sloped fire-grate has an area of 25 square feet, and a curved drying hearth an area of 32½ square feet. A great change was made in the charging hole, which is in the form of a hopper, 3 feet square and 3 feet 8 inches deep, placed at back and common to two cells. This charging hopper has a flat bottom, and when filled up with refuse to the level of the deck top of the destructor it effectually seals up the openings at the back of the cells, but allows of the charging and moving forward of the refuse by the pokers. This form of hopper has prevented the refuse round the charging holes from taking fire as formerly. The altered position of these hoppers has also given a greater area for storage of refuse on the top of the destructor. The greatest change made, however, was in the front exhaust exit flue for the gases from the cell. This was placed at the top of the level reverberatory arch, but at the front of the cell instead of the back as formerly. This change has been entirely successful in its purpose, which was to make the gases, empyreumatic fumes and vapours from the new charge of refuse on the drying hearth pass over the hottest part of the fire on the grate bars before going into the branch flue from the cell to the main flue. The branch flues from the cells are taken over the top of the cell arch and, being about 12 feet in length, these present a large area of very hot brickwork, which everything coming from the cell must encounter on its way to the main flue. The main flue was also very much decreased in size, and is now 4 feet by 7 feet 1 inch.

Another important improvement was made in the construction of the deck top so as to prevent heating of the refuse lying thereon, and to obviate any "cooking and stewing" of the material. A layer of 3-inch agricultural drain tubes was laid all over the top of the destructor deck; this was covered with Portland cement concrete 6 inches thick. One end of these tubes was left open, and the other end connected to the down-take air shafts of the forced blast apparatus. By this means a continuous stream of cold air is sucked through the pipes, the refuse on the deck top being kept comparatively cool, and the former nuisance from nauseous smells in the charging houses from the overheating of the refuse has been overcome. From previous experience in burning, and taking into account the peculiar nature of Edinburgh refuse, it was found necessary to provide a thoroughly effective system of forced blast to all the cells. For this purpose two main air-ducts, each 2 feet 6 inches by 4 feet 9 inches, were built under the cells between the ash-pit and the main flue. These air ducts are connected to two down-take air shafts in the charging house, so that all the air used for the forced blast is taken from the vicinity of the destructor top, and assists materially in changing the atmosphere there. In each of these down-take air shafts is placed vertically a blowing trumpet 6 feet 9 inches long, and at first had a steam jet 18 inches wide, but these have been replaced by 3 separate steam jets, each 2½ inches wide, in each trumpet.

From the forced blast air-duct, cast-iron boxes are taken along each side of the cells at the level of the fire-bars. These boxes are 13 inches high, and are covered on the faces with two movable plates to each; the object of placing the boxes in this position being to prevent the clinkers on the fire adhering to the sides of the cell. It is well known that where only brick sides are put into destructor cells a lot of labour is expended in cutting off the clinkers from the brickwork, which consequently needs frequent renewal. From the bottoms of these two cast-iron side boxes, four connecting tubes are provided for the supply of the forced blast to the ashpit below the firebars. These are controlled by sliding ports operated by handles from the front of the cells, for shutting off the blast when the cell is to be clinkered or a fresh charge of refuse put on the fire. The ashpits are closed in front, and provided with air-tight doors for the removal of the very fine dust which falls through the fire-bars. The original rocking fire-bars were put into the new cells, but these have all been replaced, with the exception of one cell, which still has the old rocking bars, with V-shaped steel fire-bars 5 inches deep, with ¼-inch spaces between, riveted up in sections, and stretching the full length of the fire grate. In the proper burning of refuse and the making of good clinker there is such a close relationship between the nature of the refuse burned, the form of the bar, the width of spaces between the same, and the pressure of the forced draught put on, that no satisfactory statement can be made about these without giving the records of a larger and more successful experience than has been had at Powderhall destructor. The cause for this has been largely due to several defects in various parts of the apparatus of the destructor, rather than in the type of destructor. For example, a very serious defect in the Horsfall furnace is to be found in the side boxes of the cells. The movable plates covering the faces of these boxes frequently crack, buckle up, and get twisted out of shape, with the result that the leakage of the forced blast takes place directly into the cell and over the top of the fires, and the effect of the blast in the ashpit is, to a large extent, lost, and, in some cases, entirely neutralised.

It is obvious if ten side boxes for forced draught are connected to one of the air-ducts, and if ever one of these has its plates defective and allows the forced blast to leak, the whole pressure in the ashpits of the five cells on one side of the destructor is reduced. Again, these side plates are so situated and fixed that no single plate can be replaced until all the furnaces are damped down at the end of the week. The leakage of the forced blast into the cells above the fires forces fumes and smoke out at the hoppers, when the men are charging the cells, into the charging houses, frequently causing a temporary nuisance, and when clinkering the fires, the blast being cut off in the ashpit is only increased over the fires, a result the entire opposite of which should be the proper condition of things.

Turning now to the forced blast itself, even under an average condition of side boxes, the experience has been that not more than ½ inch of water column pressure is got in the ashpits, and it need hardly be said that this pressure is entirely inadequate for the burning of refuse which has nearly *double* the quantity of fine, sandy and dusty matter and street sweepings in it than that of an ashpit town, or even of the refuse of London. The steam jet and blowing trumpet of the forced blast apparatus in this destructor were at first worked at a steam pressure of 35 lbs. per square inch, but through corrosion in the steel lips of the jets, the pressure was greatly reduced. The length of lips of the two jets was 36 inches at first, and these worked for one year, but the Horsfall Company, in January of this year, put in six new steam-jets of a total breadth of 15 inches, with brass lips to the jets, and the steam pressure had to be raised to that of boiler pressure, viz. 75 lbs. per square inch. This has been very hard work for the boiler, and it now remains to be found by what means the steam pressure can be reduced or economised, and a more effective forced blast given in the ashpits; but it is doubtful if this result can be obtained until the side boxes are put on a more satisfactory basis as regards non-leakage into the cells.

Turning now from the destructor itself, the dust catcher and heat storage chamber deserve attention. This apparatus was specially designed and erected by the Horsfall Company, so as to meet the conditions specified in their contract as to the interception of all dust coming from the destructor flue, and for the provision of a large chamber, highly heated, in which all the noxious fumes generated would be effectually cremated and destroyed. It consists of a large block of brickwork, 18 feet in diameter and 13 feet 7 inches high, situated at the one end, and connected with the main flue of the destructor. The internal arrangement consists of a spiral flue traversing the entire circumference, and winding upwards to the top of the chamber. There is an internal chamber, 6 feet diameter and 12 feet high, having a domed top, and communicating with the outer spiral flue by four ports at the top of its walls. In the floor of the outer spiral flue several dust traps are formed. These are provided with doors in the external wall of the chamber, through which the dust deposited can be easily removed. From the bottom of the internal chamber there is an opening connected to the bye-pass flue, and onother opening and flue to the front of the multitubular boiler, and, by arranging the dampers, the gases from the dust catcher may either be sent through the boiler tubes or passed through the bye-pass flue.

Inspection holes are formed at different levels for looking into the chambers; from which the heat may be estimated, and the clearness of the atmosphere inside noted. The large heat-storage capacity in this chamber, the long spiral circuit which the gases have to travel against the highly heated brickwork, the baffling of the current and period of quiescence given to the gases, thereby relieving the pressure and promoting expansion, also favours their decomposition, and provides effectually for the deposition of any dust they contain. This apparatus has given no trouble of any kind, requires no attention, except the weekly cleaning out, and has proved very successful for its purpose. The reservoir of heat, maintained at a steady temperature of from 1500° F. to 1800° F., is also very useful in keeping up steam in the boiler at an equable pressure for a long period. It is obvious, however, that the proper manipulation of the boiler damper, and the bye-pass flue damper, are important elements in the successful working of this dust catcher and heat storage chamber, so as to keep its temperature as near 1800° F. as possible.

As the quality of the refuse varies from day to day, and even at different times of the day, and with the state of the weather and season of the year, difficulties are frequently experienced in keeping up the heat; but experience shows that by regulating these dampers properly, this may to a great extent be overcome. Too much care cannot be bestowed on the proper design and construction of these two dampers, so that

TABLE OF RESULTS OF TWO WEEKS' TEST OF 10-CELL HORSFALL DESTRUCTOR,

First

Date.	Time.	Weather.	No. of Loads.	Refuse Weighed.			Remarks.	Refuse left on deck.			Total Refuse burned.		
								Started with clear deck.					
June.	hours.			tons	cwts.	qrs.		tons	cwts.	qrs.	tons	cwts.	qrs.
28–29	24	Dull, with showers	120	84	10	0	The refuse for the first three days was mainly composed of house refuse. For the remainder of the week a large percentage of street sweepings and sand was among the refuse delivered.	3	0	0	81	10	0
29–30	24	Ditto.	119	81	0	2		3	0	0	81	0	2
30–July 1	24	Clear, mist during night	121	81	12	0		5	0	0	79	12	0
1–2	24	Fair, strong west wind	112	74	11	0		5	0	0	74	11	0
2–3	24	Ditto.	102	69	3	0		4	0	0	70	3	0
3–4–5 (Sunday)	24	Fair, very strong west wind	85	56	9	0	..	..			60	9	0
Total loads			659	Total burnt							447	5	2
				Average burned per 24 hours ..							74	10	3

Steam pressure on boiler 75 lbs. per sq. inch.

Second

								Started with clear deck.					
July				tons	cwts.	qrs.		tons	cwts.	qrs.	tons.	cwts.	qrs.
5–6	24	Clear, strong west wind	104	71	13	2	The refuse sent to the destructor during this week had a large amount of street sweepings and sand mixed among the refuse.	3	10	0	68	3	2
6–7	24	Showery, strong west wind	102	71	8	2		3	0	0	71	18	2
7–8	24	Showery, light west wind	111	76	17	2		2	0	0	77	17	2
8–9	24	Dull, strong N.W. wind	120	73	5	2	..	2	0	0	73	5	2
9–10	24	Clear, light west wind	114	73	13	0	..	2	0	0	73	13	0
10–12	16 & 8 calculated.*	Ditto.	86	61	0	0	..	6 and 6	0 11 in carts	0 0	75	13	2
Total loads			637	Total burnt							440	11	2
				Average burned per 24 hours. ..							73	8	2

* Last 8 hours calculated. (50 tons 9 cwts. in 16 hours = 75 tons 13 cwts. 2 qrs. in 24 hours.)

Steam pressure on boiler 75 lbs. per sq. inch.

NOTES.—The average over the whole trial of total residuum by weight being, say, 28 per cent of the Edinburgh refuse measures 80 cubic feet to the ton.

at Powderhall, Edinburgh, from June 28 to July 12, 1897.

Week.

Clinker.				Clinker percentage by weight to refuse.	Ashes (averaged).			Total Residuum.				Total Residuum percentage by weight to refuse.	Temperature in Dust Chamber. (Fahrenheit).		
													Max.	Min.	Average.
													Electric Pyrometer.		
tons	cwts.	qrs.	lbs.	per cent.	tons	cwts.	qrs.	tons	cwts.	qrs.	lbs.	per cent.			
19	0	0	0	23·31	1	13	0	20	13	0	0	25·33	1316°	1292°	1304°
19	3	3	0	23·68	1	13	0	20	16	3	0	25·54	1905°	1616°	1805°
19	3	0	14	24·05	1	13	0	20	16	0	14	26·12	1903°	1525°	1781°
19	19	1	14	26·79	1	13	0	21	12	1	14	28·99	1850°	1688°	1769°
17	17	3	0	25·49	1	13	0	19	10	3	0	27·85	1744°	1636°	1698°
14	2	2	14	23·40	1	13	0	15	15	2	14	26·10	Pyrometer broken.		
Total clinker. 109	6	2	14	Average. 25·45	Total ashes. 9	18	0 = 2·20 % of total refuse.	Total residuum. 119	4	2	14	Total. 26·65	Average Temperature, 1671°.		

On forced blast 25 lbs. per sq. inch.

Week.

													Davis Pyrometer.		
tons	cwts.	qrs.	lbs.	per cent.	tons	cwts.	qrs.	tons	cwts.	qrs.	lbs.	per cent.	Max.	Min.	Average
18	14	0	0	27·42	1	13	0	20	7	0	0	29·63	1760°	1610°	1695°
19	0	3	14	26·47	1	13	0	20	13	3	14	28 68	1800°	1700°	1772°
18	3	2	14	23·34	1	13	0	19	16	2	14	25·55	1800°	1500°	1735°
18	6	0	0	24·97	1	13	0	19	19	0	0	27·18	1800°	1745°	1789°
18	6	4	2	24·91	1	13	0	19	19	4	2	27·12	1800°	1789°	1795°
†20	1	1	0	26·51	1	13	0	21	14	1	0	28·75	1790°	1750°	1755°
Total clinker. 112	12	3	2	Average. 25·60.	Total ashes. 9	18	0 = 2·24% of total refuse.	Total residuum. 112	10	3	2	Total. 27·82	Average Temperature, 1757°.		

† 12 tons 6 cwts. 18 lbs. in 16 hours = 20 tons 1 cwt. 1 qr. in 24 hours.

On forced blast 25 to 35 lbs. per sq. inch.

weight of refuse burned, the reduction of the bulk is $28 \times \frac{40}{80} = 14$ per cent. of original bulk of refuse.

Edinburgh clinker measures 40 cubic feet to the ton (before being slaked).

they will at no time get out of order, and always work perfectly. Cases have occurred where a bye-pass damper has got twisted by excessive heat and remained standing open, resisting all attempts to close it without damping down the destructor, with the result that all the heat has leaked away, and the steam in the boiler had to be maintained with firing its furnace with coal. Again, should the damper fix itself in such a way as to close up the bye-pass flue, all the heat, and perhaps too much, must pass through the boiler on its way to the chimney. This is not unattended with serious risk which should not occur, and possibly a solution of the contingency is only to be found in providing a duplicate bye-pass flue and damper.

The boiler setting and main flue were not reconstructed by the Horsfall Company, with the exception of providing a coal furnace in front of the boiler and a cleaning opening for taking out dust cleaned from the tubes in front of the boiler. In the reconstruction scheme, however, another important adjunct was added by Mr. Cooper, in the form of a second dust deposition and expansion chamber in the main flue near the bottom of the chimney. It consists of an enlargement of the main flue from 4 feet by 7 feet to 10 feet by 7 feet, but set at right angles thereto. It is provided with two fire-brick cross walls, 3 feet high, forming the floor into three compartments. This chamber has been found very useful for depositing the dust and allowing the gases to expand and cool down before being discharged into the chimney.

The circular chimney is 185 feet high above ground level, and lined with fire-brick to a height of 90 feet. It was provided with steel bands from the top to near the bottom, and thoroughly overhauled, and all cracks made good internally and externally in the beginning of this year.

The cost of reconstruction of the Powderhall destructor on the Horsfall principle, and other incidental work, has been 1500*l.*

After the Horsfall destructor had been working for about six months, a proper test extending from 28th June to 12th July 1897, or 12 working days, was made for the satisfaction of the arbiter, Mr. B. Hall Blyth, C.E.

The results obtained are given in the table on pages 232 and 233.

Mr. Hall Blyth's report comments on the trials as follows:—

"The results show that during the first three days upwards of 80 tons of refuse were daily burned in the destructor, giving a residue of clinker of about 23½ per cent.

"The average result during the whole period gives 74 tons of refuse per day, having 25 per cent. of clinker.

"During the first three days of the trial this refuse was properly selected, and the results fully come up to the terms of the specification.

"During the remainder of the trial considerable quantities of sand and dust were allowed to be mixed with the refuse, hence causing the diminution in quantity of the refuse burned.

"If the destructor is to continue to work satisfactorily instructions should be given to the inspector of cleaning that sand and dust should be carefully excluded from the refuse sent to the destructor for consumption."

At the start of the new Horsfall destructor in February 1897, the Corporation accepted an offer by the Horsfall Refuse Syndicate to dispose of the refuse at the rate of 1*s.* 4*d.* per ton. This they continued to do until May 13th, 1897, when the rate was increased to 1*s.* 8*d.* per ton. At the beginning of October 1897, the corporation took the burning of the refuse into their own hands, the services of the foreman of the Horsfall Company being retained to superintend the work under the borough engineer.

The staff and wages of workmen is as follows, viz.:—

One manager, superintending and attending to boiler, engine and electric lighting, &c., 3*l.* per week.

One engineer, ditto, 2*l.* 2*s.* per week.

Six stokers, charging the furnaces, 28*s.* each per week.

Seven ditto, attending to fires and clinkering, 30*s.* each per week.

Three barrowmen, wheeling away clinker to cooling platform, 28*s.* each per week.

There are also three men, at 25*s.* each per week, engaged in watering and wheeling away the cold clinker and dust from the cooling platform to the clinker bing. The men at the furnaces work in three shifts of 8 hours each, disposed in the work of one shift as follows:—

Two men charging the cells, with the addition of one extra man on the night shift.

Two men attending and clinkering the fires.

One barrowman wheeling clinker and ash from clinkering house to cooling platform.

Work goes on continuously from 10 o'clock on Sunday night to 10 o'clock on the Saturday night following, the fires being damped down on Sunday. Flue cleaning is done weekly or fortnightly, as required, by the first shift beginning. The furnaces until about three months ago were charged and clinkered every one hour and twenty minutes. From the beginning of October 1897 to the end of March 1898, the average quantity of refuse burned per cell in twenty-four hours amounted to 7·3 tons. At this rate the average cost works out at 1*s.* 9·45*d.* per ton. With the object of burning the refuse more thoroughly, and trying to obtain a more satisfactory clinker, the furnaces are now charged and clinkered every two hours. It is found that the destructor could be worked with five men less under this arrangement, but the average amount of refuse burned is now reduced to 6 tons per cell per twenty-four hours. The average cost of burning at the present time is 1*s.* 9·23*d.* per ton. This amount only includes the wages of the manager, engineer, charging men, stokers and barrowmen, and the men employed in tipping the residue. No charge is included for maintenance, tools, repairs, &c., or for repayment of capital expenditure.

DISCUSSION.

Mr. J. PATON (Plymouth): It appears to me that the Edinburgh Corporation has set up a very high standard with regard to the collection of refuse. If I am not mistaken, Mr. Young says that the dust is collected daily, a system which adds enormously to the cost of collection. I must say, however, that the Corporation has been somewhat unfortunate in the erection of a destructor, and the figure of 1*s.* 9*d.* per ton for burning is somewhat alarming to me, because I have been accustomed to hear figures very much lower than that. I also understand that this 1*s.* 9*d.* per ton is without allowing for interest on capital and payments to sinking fund. It would, therefore, be of interest to know what is the actual cost of burning, including all charges. When we go before our committees or local authorities the first thing they want to know is the actual cost of the work.

Mr. C. Jones: I think Mr. Paton said something pertinent, when he mentioned that we want to know not only the cost of burning the refuse but the total cost including establishment charges and repayment of loan. That is the determining factor with our committees in deciding this question of a destructor. There is another point raised by the paper, and that is the destruction of road refuse as well as of house refuse, which is a point of importance in connection with our larger towns. It does not affect me in my district, but in many of the larger towns the destruction of the road refuse would form a serious item. With regard to the unfortunate position in which the Edinburgh Corporation found themselves some time ago, it is only from that we should be discreet in judging, bearing in mind that a destructor even now is somewhat of a novelty. We know that things go out of date rapidly in these fast changing days; but we must still give credit to those who went in front in this matter, and made the way straight for those who come after. I say we ought to feel thankful to those who took up this question in the embyro state. There are some features in the paper that are of striking interest, and perhaps one of the most important is the very last clause in the report of the arbiters. The gentlemen make several recommendations, and the last of their recommendations is "that more intelligent and experienced stokers should be employed in the working." To me this assumes the most important aspect of the whole affair. With a destructor, like most other things, it is the intelligent working of the little details that go to make up the prosperity of the whole. It was my good fortune to come down to Edinburgh with Mr. Cooper and Mr. Laws, to go over all these matters, and strangely enough we arrived at very much the same conclusions as the arbiters, viz. that the principal defect in the whole thing was that it was not intelligently worked and that there was a divided authority. What I want to impress upon you is this. A destructor in itself is a valuable adjunct to every town, whether it is on the low temperature principle, of which I am supposed to be a great advocate, or whether it is on the high temperature, which is just now flooding the market, but whichever it is, the whole thing rests upon it being intelligently worked as to whether it is a success or not. Questions have been raised as to the expenditure ; and Mr. Paton criticises the cost per ton of refuse. I must candidly say that the cost per ton given by Mr. Young in the paper staggers me. I have worked my destructor at a low temperature, and whether I burn 6 or 7 tons of refuse per cell per day is a matter of no great moment, but I do get a splendid clinker, while the gross cost is only 1*s.* 6½*d.* against your 1*s.* 9*d.* per ton. Then there is the further question, whether you are to add the permanent charges, repayment of loan, &c., which may mean a further 5*d.*, 6*d.* or 7*d.* per ton, and the addition of which may mean all the difference as to the financial success or otherwise of the system. You may put up a high-temperature furnace, which may do a very large amount of work, but if that work is done at an excessive cost you had better fall back upon a system which does not produce such starting results, but in return gives you a result much more satisfactory so far as your Chancellor of the Exchequer is concerned. I must say I consider the cost put down here is most extravagant. I think the utmost limit of my cost has been 1*s.* 6½*d.* per ton, and when I tell you that I reduce that charge, by the splendid clinker which I obtain, and of which I never have a ton to spare (using it for many purposes, construction of sewage tanks, foundations of buildings, the making of artificial stone, bottom of new roads, &c.), to a net cost of 3½*d.* per ton by the assets I create, you will perceive how heavy is the cost of destroying the refuse here in Edinburgh. Therefore you have not to look solely at a high-temperature destructor from the point of view that it will burn up so many tons of refuse, but at the result as shown in the cost of the work it does. I am not ashamed to say I believe my "fume cremator" led the way along which many improvements have already been made. Of course as time goes on we must all give place to others. Possibly the next time we come to Edinburgh we shall find something a long way in front of anything we can see to-day; and shall be prepared to give credit to those who have brought about its accomplishment. My own work with the fume cremator, extending over thirteen years, is now well nigh over. Referring again to the various points in connection with destructors that have been raised, I have only one thing more to say, and perhaps it is somewhat outside the ordinary line of the paper—that is to express my strong opinion and advice to those who are about to go into this matter to give very little heed to any "destructor" beyond its being what its name implies. I regard that as a matter of the first importance, because day by day as my newspaper cuttings come in I see the tendency to mislead the economical Members of our Councils, and persuade them into the idea that they are going to get a marvellous lot of work out of nothing, indeed, that they are going to light their towns by electricity out of the burning of the refuse. When the economical Members of our Councils see these fine statements they turn round and say, "how is it that our surveyor has not brought this paper before us." But the Members of Councils are not usually behind the scenes as we are, and do not know that these things which are put forward with such a flourish of trumpets, go no further perhaps than the formation of a company or the advertisment of some particular patent. They do not take into consideration that in certain districts probably the house refuse is of a class which you cannot match in any other parts of England, or that the refuse has a calorific value that no other town in England can compare with. Only yesterday a newspaper cutting came into my hands to the effect that a certain vestry had found that their refuse was infinitely better in calorific value than the refuse of another well-known place. Probably the next newspaper cutting that comes will be to the effect that some one has found that the refuse of a town in the north is better still, and so on. There are certain individuals who would persuade you that you can have a town lighted with electric light, and electric tramways running through all the streets, from power produced by the burning of house refuse. I would reply that a destructor is a means of destroying house and road refuse, and there you had better leave it; and whatever you may do with the steam and power that may be produced from the burning of the refuse, do not trust it as the source of either light or power. If you put up electric light works let them be independent and you may be successful, but if you depend upon a thing which is intermittent, and must be intermittent, you will make a big mistake, whatever the various patentees of destructors may say.

Mr. C. F. **Wike**: One can understand that in a city like Edinburgh, which is famous for its picturesque architecture and natural beauty, the inhabitants would be jealous of anything which would detract from either characteristic. In cases like this it would be very easy to get up an agitation against a destructor. It is, in fact, always easy to get up such an agitation. As an instance, I may say I recently erected a destructor in a district of Sheffield which is in the midst of large works, furnaces and collieries, from which great quantities of smoke and objectionable fumes are emitted, in fact, the district was one from which it was thought no complaint could reasonably be made. It was not long, however, before an agitation was worked up, and complaints were received as to the smells emanating from the chimney. The complaints were allowed to go on for some time, until the chairman was interrogated at the council meeting. His reply was very simple, but effective, viz. that during the time the complaints were made the destructor had not been working. This only shows how far imagination will go. The destructor consists of six cells and now consumes over 10 tons per cell per day. The temperatures obtained are from 1500° to 2000°. This high rate is, however, achieved to some extent at the expense of the fabric, and some of the fire-bricks in the cells will soon require renewing. The residue after burning is about 27 per cent. As to the cost per ton, it is difficult to get sufficient reliable information to enable comparisons to be made between one type of destructor and another, as the different rates of wages, cost of management, &c., have to be taken into consideration. For instance, in some towns the men work two shifts and in others three, which, of course, proportionately affects the cost even if the destructors are of the same type.

Mr. D. MACKENZIE: I should like to support the opinion expressed by Mr. Jones, that the proper object of a destructor is to destroy refuse and not to become a wealth producer. We should insist, as sanitary engineers, that the refuse of our towns should be thoroughly and completely destroyed. I am pleased to think that the Edinburgh people are prepared to pay the price they do to maintain a great heat and thus thoroughly destroy their refuse.

Mr. J. PARKER (Hereford): I cannot quite agree with the views expressed by Mr. Jones, that "destruction" is the only aim. An equal interest is manifested with respect to the utilisation of the heat generated by destructors from the burning of refuse. Though some of us may be old fogeys we cannot afford to remain stationary. There is undoubtedly a useful heat which produces a certain and not inconsiderable calorific value in the burning of house refuse, and I differ from Mr. Jones as to how we should utilise that calorific value. Wherever we see a destructor doing work and raising steam power in large and useful quantities from the burning of refuse, I think it right that the Members of the Association should be put in possession of the fact, so that if they have a destructor they may employ it to similar advantage. I must say I was struck by the heavy cost per ton involved by the burning of the refuse in Edinburgh. We are paying at Hereford about 7*d.* per ton for this purpose. The weight burnt per square foot per hour is 58 lbs., and the clinker which is produced is utilised for the making of artificial stone, &c. The amount of steam raised is 1·32; and if you can obtain this amount of power from the burning of refuse it is something we ought to strive for, as it very materially reduces the net cost of the work. It is no doubt true that a refuse destructor is a great step in advance, but if there is a calorific value in the dust which we destroy we are perfectly right in searching for and utilising it to the utmost extent. The following table shows the results at Hereford, which, weight for weight—refuse and steam—I have not yet seen exceeded.

Mr. JONES: I have been using the steam produced by my destructor for the last thirteen years, and have had no other means of working my engines. It does not matter whether I am working to produce steam or electric light, but I certainly warn you against trusting the intermittent power you may obtain from this source to work an electric lighting installation.

Mr. W. HARPUR: I should like to second the vote of thanks to Mr. Young for his most interesting paper. At the same time there is one question I should like Mr. Young to answer very briefly, and that is: to what does he attribute the success in Edinburgh of getting rid of the nuisance which they formerly had; is it to the alteration of the cell or the construction of the dust-catcher, or a combination of both?

Mr. J. COOPER: The reason for Mr. Young's bringing forward this destructor question for discussion is that we may, through this Association, gather up the experience of the country. I must say we have experienced much adverse criticism in Edinburgh in regard to this destructor, and no

TESTS MADE ON "MELDRUM" PATENT DESTRUCTOR FURNACE AT THE CITY OF HEREFORD OUTFALL WORKS.

1. Date of test	May 4, 1898*	May 5, 1898.†	May 6, 1898.‡
2. Duration of test	10 hours (7 a.m. to 5 p.m.)	10¼ hours (7.15 a.m. to 5.30 p.m.)	10 hours (7 a.m. to 5 p.m.)
3. State of weather	Steady rain to 8.30, when it cleared.	Fine at start, commenced to rain at 1 o'c., and continued to end of test.	Fine all day.
4. Kind of fuel burned ..	Unscreened ashpit refuse.	Unscreened ashpit refuse.	Unscreened ashpit refuse.
5. Total weight of fuel burned	19,768 lbs.	19,012 lbs.	19,712 lbs.
6. Weight burned per hour..	1,976 lb.	1,855 lb.	1,971 lb.
7. Weight burned per sq. ft. of grate area per hour.	54·88 lbs.	51·52 lbs.	54·75 lbs.
8. Total weight of clinker and ash.	6,699 lbs.	6,804 lbs.	5,040 lbs.
9. Percentage of clinker and ash.	33·88 %	35·7 %.	25·56 %.
10. Percentage of moisture ..	24·5 %	27·0 %.	25·0 %.
11. Total water evaporated ..	26254·58 lbs.	25,570 lbs.	29,800 lbs.
12. Water evaporated per hour	2625·45 lbs.	2494·63 lbs.	2,980 lbs.
13. Do. per lb. of refuse, actual	1·32 lb.	1·34 lb.	1·51 lb.
14. Do. do. from and at 212° F.	1·58 lb.	1·60 lb.	1·82 lb.
15. Temperature of feed water	48°	48°	48°.
16. Average steam pressure ..	70 lbs.	70·2 lbs.	70·92 lbs.
17. Do. at blowers	64·37 lbs.	64·55 lbs.	65·21 lbs.
18. Average temperature of superheated steam to blowers.	320·65° F.	319° F.	319° F.
19. Average pressure under grates, by water gauge.	1·45 in.	1·37 in.	1·82 in.
20. Average chimney pull, by water gauge.	⅜ in.	⅜ in.	⅜ in.
21. Average temperature in combustion chamber by copper test.	2000° F.	2000° F.	2000° F.
22. Do. of waste gases at chimney base.	(25 readings). 611·5° F.	(36 readings), 638·8° F.	(41 readings), 715·12° F.
23. Average percentage of carbonic acid (CO_2) by econometer.	(25 readings), 15·56 %.	(39 readings), 16·84 %.	(41 readings), 16·27 %.
24. Do. do. by Orsat apparatus.	(20 readings), 14·92 %.	(16 readings), 16·83 %.	(14 readings), 16·38 %.
25. Do. of free oxygen (O) by do.	(20 readings), 5·40 %.	(16 readings), 3·54 %.	(14 readings), 3·74 %.
26. Do. of carbonic oxide (CO) by do.	(20 readings), nil.	(16 readings), nil.	(14 readings), nil.

---

* During the above tests, the sludge presses and liming plant worked the whole time. Both sewage pumps worked from 7 o'clock to 10.50, after that one pump only. Steam in excess was allowed to blow off.

† The sludge presses and liming plant were running the whole time. Both pumps from start to 11 30, then one pump till 3.45, then both again to the finish. Steam in excess allowed to blow off.

‡ The sludge presses and liming plant worked the whole time of test. Two pumps worked from 7 o'clock to 11.20, then one pump for the remainder of the time. Steam in excess allowed to blow off.

doubt some of it quite justifiably. Latterly, as Mr. Young has explained, we have adopted a method which has abated the nuisance from the chimney and otherwise. I refer to its reconstruction by the Horsfall Company. Now there is raised the question of utilising the heat from the destructor. The other day, when Lord Kelvin was here making examination of the destructor at the instance of the Horsfall Company, he told us that he believed we could utilise the heat and turn it into steam, and thus have a regular 300 horse-power supply from this destructor. Lord Kelvin said if we could utilise the steam thus produced we might burn our refuse for nothing. Well, we should be very glad to dispose of our refuse so cheaply; I admit the present cost of burning is very unsatisfactory. We are constantly being told that Bermondsey and Shoreditch and Leyton are disposing of their refuse and lighting their districts with electricity, and so on, from the power which the burning of the refuse produces We have not investigated these statements, and therefore do not know whether they are true or not. We should be very glad to have had incisive criticism of this paper, for we are anxious to get the best thing possible. There is no doubt that in principle we have established the fact that the destruction of refuse by burning is the right thing for large cities, and that the day will come when they will all have to dispose of their house refuse in this way. We are getting rid of a large proportion of our refuse in Edinburgh by "dumping" it into a large disused quarry situated in the country, and the tipping of it there costs us about 1*s*. 6*d*. per ton. That is also an excessive price, and we do not know what mischief we are doing in poisoning the water springs of the surrounding neighbourhood. We have, as already explained by Mr. Young, employed the Horsfall Company to reconstruct the Manlove, Alliott and Company type of destructor, because their specifications exactly met the requirements of the experts appointed by the Court of Law, and we thought if the experts approved of their method we were safe in employing that company to do the work. They have still to complete the year's maintenance of the destructor agreed upon. It is almost a pity they had not completed their contract before you visited the destructor, but after the repairs are completed we shall be left with this apparatus to make the best and the worst of it. How long it will last I cannot say. The enormous heat generated is constantly wearing down the appliance. But what we want to get at the bottom of is how best and cheapest to dispose of our house refuse. We have not adopted Mr. Parker's method of making artificial stone, neither have we been able, by utilising the clinker, to reduce the cost, as Mr. Jones has done, to 3½*d.* per ton. We should be happy if we could do so. We brought Mr. Jones down here when we were in the Courts of Law, and he left us helplessly in the hands of our enemies. I may add that we put our destructor in the neighbourhood of a mansion with beautiful gardens, and the owners were taking notes for evidence while we were asleep, a proceeding for which we had to pay sweetly.

BAILIE MACKENZIE (Edinburgh): As one of the members of the Town Council, I came here to get a great deal of light on this question, one aspect of which I have studied for some time. We read in the newspapers, and sometimes even in the technical journals, that in London they are able to destroy the refuse and get a great deal of power out of it, even making a profit out of it. When the Shoreditch destructor was inaugurated, we heard of its value for electric light production. But I gather that when the Shoreditch people published their accounts for the first nine months' working, they were in such a hopeless state of confusion that nobody could make head or tail of them. Mr. Hammond, a consulting electrician, who lays himself out to analyse electric light accounts, admitted, when these accounts of the Shoreditch Vestry came before him, that they were very wonderful, but he could not make anything further of them. For instance, he found 10*s.* 6*d.* for a cape for a particular individual, but nothing was put down for wages for the same man. We people, who are ordinary tradespeople, came here expecting to hear the truth about this matter. We are burning a large amount of refuse in Edinburgh, and we were told that we ought to utilise the heat which that refuse produces. Well, we consulted an expert, and we were told if we planted our electric light works at the destructor we might get 150 or 200 horse-power from the refuse burnt, but as that was a mere drop in the bucket we did not think the game worth the candle, and erected our electric lighting station elsewhere. I think you gentlemen should speak your minds freely and put down the humbug which is talked of getting so much power from the burning of refuse in a destructor.

MR. A. E. COLLINS: I do not think sufficient attention has been paid in the discussion to the very large bulk of the Edinburgh refuse in proportion to its weight, and the difference that will make in the cost of burning it. If you have refuse which is half the weight, bulk for bulk, of other refuse, it will cost approaching twice as much per ton to handle it. With regard to the Horsfall furnace, I am surprised to hear there is any nuisance from it. In Norwich we have a small installation on the Horsfall system in the middle of the city, and we get absolutely no complaints at all.

Mr. Cooper: There is no complaint since the Horsfall system started.

Mr. Collins: With reference to the power to be obtained from the working of the destructor, I may say when we get our winter refuse we can get a very useful horse-power from the cells—perhaps 80 to 100 horse-power from two cells—but now (June), when we get a considerable amount of garden refuse, the horse-power obtained is not nearly so much. The power you obtain varies very much according to the refuse you are burning, and where a town collects all the refuse, as we do, you cannot rely upon the destructor for producing a constant amount of power.

Mr. Young: It exactly represents the destructor at Powderhall, with this exception—that below the grate bar there are two tubes carried down specially for the forced blast. We have side boxes which go along each side of the cell above the grate bar; and there are valves on the two tubes which I have mentioned. These side boxes are covered with plates which occasionally get buckled, and the blast then leaks directly into the furnace. That is one of the disadvantages of this type of furnace. If you can keep the side boxes quite tight it is right and works well, but if you get them cracked the pressure falls off until such time as you get them repaired.

Mr. Campbell: It seems to me further that a great deal of distillation of dry refuse must take place from the method of discharge into the hoppers. There must be a great deal of vapour and foul odour go up from there (Mr. Young: No). That, at least, is the aspect of the arrangement which has presented itself to me. I may be wrong, but I do not think I am.

On the formal proposition, a hearty vote of thanks was then accorded to Mr. Young for his paper.

CONVERSION OF EDINBURGH, LEITH AND PORTOBELLO HORSE TRAMWAYS SYSTEMS INTO CABLE TRACTION.

BY WILLIAM NEWBY COLAM, M. INST. C.E., M. INST. M.E.

THE Author regrets that the time given for the preparation of his paper has not been sufficient to enable him to deal with the subject in a more technical manner, but he hopes the practical results of working given will be of some use to the Members.

On the occasion of your Association's last visit to this city in the year 1890, the Author had the pleasure of submitting a paper explanatory of the construction and working of the Edinburgh Northern Cable Tramways, and on this occasion the Author trusts it may be considered opportune to lay before the Members the last eight years' experience in operating these lines, and to describe the conversion from horse to cable traction at present in hand within the Edinburgh boundaries, and also as about to be proceeded with in the Leith domain.

In 1890 the cable system in Edinburgh was in its infancy, as the second line built had only been opened to the public in the month of February of that year, and the first line in January 1888. The information available at that time as to the operating costs was not reliable, because the lines had not been at work long enough to ascertain how far the working costs would be increased after the lines and machinery had been in use for some years. This can now be given without any dubiety from the regular balance sheets for the last ten and a half years up to the date when the Corporation of Edinburgh bought up the lines at a price which yielded a profit over the original cost of construction of about 30 per cent.

The conditions under which these lines have been compelled to operate cannot be considered conducive to the best financial results for either receipts or expenditure, for the following amongst other reasons:—

1. The maximum speed was limited to six miles per hour when the system was inaugurated, mainly because it was something new, and has not since been raised because in the hilly district perhaps slow speed is not so noticeable.

2. No Sunday traffic on tramways has been permitted.

3. The routes are most exceptionally hilly.

4. The ends of the routes are not built over, and lead nowhere in particular.

5. The engines are high-pressure non-condensing, working at low pressure of steam.

6. There are no economiser means of utilising the gases; nor feed water heaters.

7. The whole managerial department was in London, which necessitated heavy travelling expenses.

Notwithstanding the unfair limitation in speed and other drawbacks, the results have been eminently satisfactory, as will be seen from the following statement (Table No. 1) made from a comparison of results in 1890 with the last year of the company's working in 1896.

TABLE No. 1.

Year.	Motive Power.	Maintenance.	Total.	Car Miles.	Passengers.
1890	£1279	£2219	£3498	222,822	2,582,620
1896	£1180	£2710	£3890	376,725	3,715,989
Increase %	..	22·12	11·23	69·06	43·88
Decrease %	7·74	..	..	..	..

NOTE.—*The Motive Power* includes wages, coals, oil tar, waste, water, and engine-room requirements. *Maintenance* is for road, cars and plant.

The tabulated results of No. 1 must be somewhat puzzling to the uninitiated in cable haulage, because, when analysed, they show that although the mileage has been increased 69·06 per cent., and the number of passengers carried increased 43·88 per cent., the cost of motive power, instead of being greater, happened to be less.

The reduction in cost of motive power has been due to improvements and a slight reduction in the price of coal, and the reason for no increase is that the loads up and down balanced on an average. These figures once more prove that cable haulage is able to enormously increase its car service and so provide for the future without appreciable increase in its working expenses.

It will be observed from the returns of working that, whereas the number of passengers only increased 43·88 per cent., the car mileage increased 69·06 per cent. This is most important to note, because it points to a factor peculiar to cable haulage. It is directly in the interests of the management to improve the service of cars beyond even the requirements of the public, because, beyond the wages of the drivers and conductors, very little extra is incurred in placing each additional car on the line.

Even more satisfactory results than are shown in Table No. 1 were recorded on one of the cable lines during a week of greatly augmented traffic, and the Author now presents these figures, believing them to show the most unique results for the conditions of operating which have ever been obtained in tramway practice in Great Britain. The ordinary weekly working expenses given in the Table were arrived at by a division of the yearly certified accounts of fifty-two weeks, and the increased cost of operating was carefully checked during the week, and was mostly due to wages and gratuities given to the men and inspectors for close attention to their duties.

Table 2 shows that with the same fares a cable tramway was able to increase its receipts 311 per cent. by a rise of working expenses of 12 per cent. only.

That by quickening the service of cars by 1⅛ minute, when the traffic would warrant it, the working expenses per car mile run were reduced ⅜*d.*

That the tons hauled per mile increased 24 per cent., and the cost of hauling a ton mile was reduced 33 per cent. *This is elasticity in the right direction, and the Author is of opinion that Local Authorities and Tramway Companies too often* *make the mistake of not thoroughly arriving at sound conclusions as to the elasticity of a mode of traction in this direction when considering the initial cost of systems under scrutiny.*

TABLE No. 2.

Year 1893.	No. of Cars.	Mileage of Cars.	Passengers.	Tons hauled per Mile.	Cost per Ton Mile in Pence.	Total Receipts.	Total Expenses.
Show week, 24th to 29th July	47	3395	112,663	7·14	·75	£ 468	£ 75
Ordinary week. Average 4 weeks	36	2514	27,541	5·75	1·11	114	67
Increase..	31%	35%	309%	24%	..	311%	12%
Decrease	..	..	..	..	33%	..	..

The last return of the company's workings showed that the cost per car mile, including every charge possible, excepting depreciation and interest on capital, was 5·2 pence, notwithstanding the restriction on speed and the severe hills, &c. The receipts per car mile had only been 10·13 pence, which was just about what the *cost* per car mile run has been on the horse system of Edinburgh. The foregoing facts conclusively prove that the lines have been a great success financially, and the fact of the Corporation of Edinburgh still favouring cable should be sufficient authority for the statement that mechanically they have met with public approval.

Having now brought the paper read before you in 1890 up to date, the Author will lay before the Members some particulars as to the big system of cable haulage which the Corporation of Edinburgh are nearing the completion of.

The Corporation of Edinburgh has purchased all the tramways within the limits of the borough, and they have leased the working to a company for 21 years, the company agreeing as follows—

1. To pay interest of 7 per cent. upon the price paid by the Corporation for old lines, and the same rate of interest upon all sums of money expended by the Corporation in converting to any form of mechanical traction they choose.

They also agree to set by each year a fixed sum of money sufficient to return the capital of the lessees, and to ensure the tramway lines and other works being left in a thoroughly good condition when the lease expires.

2. To pay the cost of maintaining the tramway tracks and other works.

3. To reduce the hours of workmen as desired by the Corporation.

4. To pay 3 per cent. upon sums expended by the Corporation in reconstruction until the lines are finished.

The Corporation, by borrowing the necessary money for the purchase and construction of lines at 2½ per cent., and by getting 7 per cent. from the lessees, will be able to write off the cost of the tramway system within the terms of the lease.

The Author thinks that the Corporation is to be congratulated upon the arrangement made, and suggests that those who advocate municipal working of tramways might consider the Edinburgh arrangement worthy of favourable reflection.

Before entering upon descriptive matter, it may be of primary interest to give what the Author believes to have been some of the Corporation's reasons for adopting cable haulage in preference to other mechanical powers which have found favour elsewhere.

First of all, it must be stated that the original lines were self-contained, and were in no measure the inducement for extending the system for the preservation of continuity.

Secondly. The overhead wire system of electricity, which was the only other system reported as being anything like a financial success, was not entertained in Edinburgh because of its interference with the amenities of the city.

Thirdly. Because the contour of the city is peculiar in being exceptionally hilly, and where so many hills exist in a city, it is of paramount importance that the speed ascending hills shall not be less than that attainable on level portions of the routes.

Fourthly. The buildings limit line of the city is more markedly defined than in most cities.

Fifthy. The cable system in Birmingham, London and Edinburgh had placed the fact beyond a doubt that the Corporation could treat for a lessee with full knowledge of what would be an approximate working cost per car mile with the cable system, whereas by any other system which could be in any way considered, no such reliable information was available, particularly from experience of operating under British Board of Trade Regulations. Further, it is within the Author's knowledge that eminent electrical opinion has been given that Edinburgh is not a suitable place for electric traction in any form.

The following table gives the miles of lines within these respective districts reduced to single track of tramway.

TABLE No. 3.

—	Miles of Double Track.	Miles of Single Track.	Reduced to miles of Single Track.
Edinburgh	19·004	·700	38·708
Portobello	2·110	..	4·220
Leith	2·165	·170	4·500
Total ..	23·279	·870	47·428

No. 1 is one of the new depôts from which all the cables in the south-west and westerly districts are to be operated, and provision is here made for extensions in these districts.

No. 2 depôt is being constructed on a portion of the stable land of the horse tramways, and from here the whole Leith and south-east cables will be operated.

No. 3 depôt is to be a small depôt principally for the storage of cars for the eastern district, but an engine is to be placed here to work the Portobello and Waterloo Place lines, at higher speeds than would be convenient through the centre of Edinburgh.

The old cable depôt at Henderson Row will not be done away with, as it will be useful for extensions of the system on the northern districts.

Throughout the system there will exist nearly all conditions of tramway operating which are to be met with in ordinary practice. For instance, the grades are as high as 1 in 11, there are right-angle branches, "S" junctions and compound triangular junctions to be worked. Single lines of track with passing places are not common, but at places are required.

Cross traffic, where cables cross each other, have also to be dealt with. Bridges and cellars have already been crossed by the cable construction in Edinburgh, when clearances of 14 inches only from the surfaces of the roads have been available, and lastly, an arrangement for crossing a swing bridge in the Leith district has been designed.

Arrangements are made by which the traffic can be returned (or short circuited) through turn outs when the management considers it will be advisable during parts of the day to provide an augmented service of cars short of the terminus of the route, and such provision is also made for isolating a cable section where a block may occur.

The general speed of cars throughout the Edinburgh district is to be eight miles per hour, but passing round important corners and over congested crossings, the drivers of cars will not be able to acquire a higher speed than four miles per hour, and they will be able to go as much slower than four miles as may be required.

Provision is being made to increase the maximum speeds when the Board of Trade may give permission. In the outlying district of Portobello, it is expected that the Board of Trade will raise no objection to nine miles.

The permanent way will perhaps interest the Members as much as anything on the cable tramways at their present stage of construction. The track rails are of the usual type now common for tramways, and are 6½ inches deep, weighing 83 lbs. to the yard run. The joint adopted by the Corporation of Edinburgh was quite new, as will be seen from the specimen produced. The two objects sought to be obtained are—

Firstly. That the wheel in rolling along the tread of the rail shall not, in passing from one rail to the other, be left without a support, and thereby it is hoped that all chances of concussion due to break-joint will be abolished.

Secondly. That by the arrangement of recessed nuts and flat cheese-headed bolts, the paving may be brought square up to the edges of the rails, and the Author submits these two improvements are of very considerable importance.

The tests of 42 to 44 tons per square inch for tensile, 15 to 20 per cent. on 8 inches for elongation, and 40 to 45 per cent. contraction, called for in the specification, were objected to by British manufacturers, but the engineers are pleased to report that the effort was made and the tests were fully obtained, with the result that extremely hard and yet tough rails have been laid in the system.

The slot rail, a specimen of which is also shown, weighs 48 lbs. per yard, and are made of a somewhat milder steel than the track rails, the tensile asked for being 39 tons to the square inch, with 15 per cent. elongation and a contraction of 30 per cent. The actual amount of metal appearing on the surface of the street in these slot rails is $1\frac{3}{16}$ inch. Against these rails also it will be observed that the paving setts can be placed right up to the edge of the rail without any chipping, and on a square bed, which is important. The Barrow Hæmatite Steel Company carried out one contract for rails, and Messrs. Dick, Kerr and Company, Limited, the other.

The points and crossings are all to be made of steel, and no facing points are used excepting where they cannot be avoided, such as at junctions.

Trailing points for track and slot rails will work by springs, but where facing points are required, the track points are connected underground to the slot points by levers in such a manner that, whichever way they are thrown over, there is a locking apparatus introduced to fix the slot correctly with the track points.

The slot points are built up of cast and spring steel.

The track points are made of cast steel, and track over slot and slot over track crossings are built up from the section of these rails, but the junctions of slot and slot are made of cast steel with renewable points.

The paving setts are granite, of two qualities as far as workmanship is concerned. Specimens of these two qualities are exhibited. Inside the track the setts are 3 inches wide by 5 inches deep, and the average length is about 6 inches. Outside the track the setts are 6 inches deep by 3 inches wide. The better quality of setts are axed on top as well as square on ends and sides. The hatch covers, which are used in the track for obtaining access to the pulleys, are filled with granite setts specially dressed, and of the same size as other setts, so that in ordinary conditions they are almost imperceptible on the road surface.

In the road construction a great deal of wood has been used, and this has chiefly been of the hard Australian qualities.

In some cases the wood has been laid from curb to curb, including inside the tramway track.

The standard distance between the tramway tracks is 4 feet, but where the streets are narrow this has been reduced to 3 feet. At places where the streets are exceptionally wide, the tracks have been spread apart to give a distance between of 6 feet, and electric light posts have been erected in the centre.

The width of the slot is specified to be in no case more than $\frac{3}{4}$ of an inch.

The terminal pits for diverting the cables at the terminal of each route are not of the design described in the Author's paper of 1890, but are so constructed that, regardless of whether the route ends on an incline upwards or downwards, the cars will proceed to the extreme end of the journey by means of the cable, and no gravitation whatever will be resorted to. This is attained by passing the cable around two large vertically placed pulleys, one behind the other, and one slightly inclined. By this means, even in a heavy snowstorm, a car could proceed through the snow to its terminus, and start out again without the tracks being cleared.

Where cables terminate in the middle of a route and meet other cables, the two cables are made to lap past each other by arrangement of large pulleys placed in a pit.

At these places the cables are so arranged that the operation of releasing from one cable and taking the other is performed while the car is at a state of rest, and will not require more than 15 seconds to accomplish the change over. The operation is practically automatic.

The reduced maximum speeds of cables for passing round important main corners in streets is obtained by the introduction of auxiliary cables, which are worked off the axles of large pulleys kept in motion by the main cable, and the main cables are thus saved from a great deal of hard work, and their lives, consequently, will be materially lengthened.

The Author feels sure that the following information as to the rate at which cable tramways have been laid in Edinburgh will be of interest to the Members.

There seems to be an idea existing that cable tramway tracks are very serious innovations for streets, because they require a tube construction besides an ordinary tramway track.

The following information will confute any such erroneous impression.

During the first twelve months of the contract, there were laid in the streets of Edinburgh a trifle over 20 miles of cable track.

The greatest speed attained was during six consecutive days, when an average of 220 yards per day was attained on one section of new lines.

It will be seen that the amount of finished work during twelve months averages out to a little more than 112 yards per working day, which would be considered splendid work for an ordinary horse tramway line, where the traffic is such as in Edinburgh, and where the tramway service has to be maintained.

The contract for road and pit work was secured by Messrs. Dick, Kerr and Company, Limited.

The depôt for the Western District is the most important, and as some of the Members may be visiting it, the Author will briefly describe the construction and equipment which is intended for this depôt.

The site is by no means an ideal one for the purpose, but by its adoption a miserable collection of houses has been removed, and a great public improvement has been effected. The buildings stand one block and a street back from the main road, and the communication between it and the main tramway is through a very narrow lane.

The principal materials used in the building are red stone and a fine quality of brick, the former being exclusively employed for the front elevations. The buildings include engine room, boiler room, chimney 180 feet high, pump room, built-in water tanks to hold 40,000 gallons, tension room, car sheds for 43 cars, cart sheds and stable for three horses, store for road work and underground stores for oils, &c., lavatories, offices, &c.

The chief station for storing, painting and repairing cars is at No. 2 station, where the sheds are divided into sections to isolate the cars in case of fire. Total accommodation for the storing of 225 cars is being provided.

The engines are horizontal compound, non-condensing, with cylinders placed side by side on separate cranks set at right angles. There are three pairs of engines attached to the one line of main shafting.

Each main shaft is divided into sections which can be connected by specially arranged couplings forged on the shaft ends. Two 14 feet 6 inches diameter grooved pulleys are mounted in the line of shafting, so that any two of the three engines can be geared to work the two pulleys. These pulleys are made for carrying 32 ropes of 1⅝ inch diameter, and they will revolve at 45 revolutions per minute. The power of the engines will be transmitted to the counter-shaft through pulleys 30 feet diameter.

The high-pressure cylinders are 23 inches, the low-pressure cylinders are 40 inches diameter. The stroke is 5 feet.

A premium of 5*l.* per cent. was offered as a bonus on the contract price of the engines for every pound of water per indicated horse-power consumed per hour less than the 20 lbs. specified.

In like manner a deduction of 5*l.* per cent. will be made, but should the consumption per indicated horse-power reach 23 lbs., the engines may be rejected.

The engine room is provided with two cranes to lift 24 tons each.

Messrs. Dick, Kerr and Company, Limited, secured the contract for this portion of the work.

The Boiler House. This is placed immediately behind and considerably lower than the engine room.

The coals taken in off the road have not far to be lifted into the bunkers over the boilers. All the pipes to and from the boilers and engines pass underneath the engine room floors without dipping, and do not appear at all in the engine room, also the low level of boilers should also reduce the chance of priming through syphoning.

The boilers are cylindrical marine type, 10 feet 6 inches by 12 feet, with super-heater tubes on the top. The gases from the fire enter a back combustion chamber, from which they pass to the front of the boiler through tubes into the smoke box. They are returned over the top of the boiler, passing on their way around super-heater tubes into a second back chamber which directs the gases along the bottom of the boilers into the main flue.

Apparatus is provided for diverting the gases down the sides of the boilers, in case the super-heater tube should require attention when the boiler is under steam. The duty of these boilers is to evaporate not less than 9000 lbs. of water per hour at a boiler pressure of 160 lbs. There are four such boilers, designed to work up to a pressure ultimately of 160 lbs. These boilers will not be worked to anything like their full capacity, and a large reserve will always be kept in hand.

The main steam piping is welded steel, and all in duplicate. The feed pipes are in copper and are duplicated. The boilers are fitted with "Vicar's Mechanical Stokers," supplied with coal from an overhead bunker running the full length of the boiler house. Coal is taken up with ropes to the bunkers in receptacles resembling contractors' steel waggons, which are so adapted that they are suitable either for use on the body of a cart through the streets or to form the tipping body of a tramway coal truck which will travel on rails over the top of the coal bunker.

There are two heaters, arranged so that they may be used together or separately. These are of the "Brown Berryman type," and each heater is capable of passing 1600 gallons of water per hour. The pumps are in duplicate, and are 8-inch double vertical "Weirs type."

The arrangement of pipes from the pumps is to effect the following

COMBINATION OF FEEDING.

(*a*) All the boilers may be fed with hot water.
b) All the boilers may be fed with cold water.
(*c*) Any number of boilers may be fed with hot or cold water.
(*d*) Any one boiler may be fed with hot and cold water.
(*e*) Any one boiler may be fed with hot or cold water.

Messrs. George Sinclair are the contractors for the work in connection with the boilers, &c.

At No. 2 depôt the arrangement of boilers and machinery is much the same as at No. 1, only the boiler house is not placed exactly in the same relative position to the engine house, but has the advantage of being at the side of a railway, so that a siding has been made by which means coals can be lifted direct up into the bunkers instead of having to be brought in carts as at No. 1 depôt. At this depôt all the smithy, repair, general machine, carpenter's, and paint shops are placed.

At both depôts the cars are brought in and taken out from the main road by auxiliary cables, and they are traversed into the repair shops or ordinary sidings by traversers, also worked by auxiliary cables.

The tension races are immediately at the back of the engine rooms, and under car shed floors. This apparatus is similar in some respects to that described by the Author in 1890, excepting that the pulleys on the main carriages are placed horizontally instead of vertically, and all the tension weights are arranged vertically upon the wall of the engine room, so that the man in charge can observe at any moment the fluctuation of strains taking place upon any one line being driven from each station. From No. 1 station there will be five cables driven, and the longest at present will be 24,000 feet, but these will all be capable of considerable extension. The longest cable in the system at present is 34,500 feet. The mode of driving the cables is somewhat as explained in the Author's paper of 1890, but the grip pulley has the improved white metal jaw which has given great satisfaction in the London Cable Tramways. Each grip pulley can be thrown out of action without interfering with any other, by means of a coil clutch of powerful construction.

Opposite each rope drive there will be an iron drum, with a spare cable for its respective route, ready at any moment to be run into the road. At the side of the engine room an engine and drum is provided for hauling out old cables, and it is estimated that the longest cable will be taken out, and a new one put in, within the space of one hour.

The gripper apparatus to be placed on the cars is an important feature of the arrangements made for cabling the Edinburgh extensions. The gripper shown in the Author's paper of 1890 would not meet all the requirements of the new lines where some cables have to be taken in the gripper to the left, and others to the right, of the direction in which the car is proceeding. The new gripper also has to be able to pass over crossing cables. It has been designed and tested on the lines of the existing cables, and can be seen by the Members at the company's depôt at Henderson Row. The whole machinery is enclosed in a cast-iron box standing on the platform of the car, and occupying about the same space as is taken up on the car by an electric tramway standard. The main improvements over the gripper of 1890 consists of provision by which the driver of the car, standing in the front of the car, can operate the gripper by his side or the one at the rear end of the car by a simple reversing of a lever. It is by this means that the driver can cross over the cable running at right angles to his path. He proceeds to a stopping point with the gripper attached to his main cable, he then by the one process lets go that cable in the front, and takes it in the rear gripper, and proceeds over the crossing of the cable. The operation takes only a few seconds, and should be quite safe, because there is an automatic arrangement provided for stopping the car in the event of the driver being forgetful or careless. Another improvement is, that the portion of the gripper which works in the tube underground can be quickly detached from the car and dropped into the tube if anything should go wrong with it. The attachment previously used direct on to the axles of the car, was found in practice to have several drawbacks, and the new gripper is fixed to adjustable bars on the bogies, and the moving parts are enclosed so that there will be no fear of oil, &c., injuring wearing apparel. There are 125 cars being built on the bogie principle. The bogies are very light in construction, being made of $\frac{5}{16}$ of an inch pressed steel frames. The chief feature about them is that the wheels are on the axles outside the bearings, and that the wheel base is 3 feet 9 inches. This is contrary to customary practice, but the Author has tried them very severely, and finds them to answer admirably. The cars are designed to seat 18 passengers inside and 28 outside, and the only noticeable departure from ordinary practice is that the insides of the cars will be domed after the manner of railway carriages, instead of the type of roof common in tramway cars.

In concluding, the Author would specially invite the Members, as advisers to their respective districts, to always insist upon arriving as far as possible at—

Firstly. The saving which can be effected by any particular system over the whole period in which that system is intended to operate, before allowing the initial cost to have any influence upon the minds of their committees.

Secondly. To compare (at least in a common-sense way) with existing systems the cost of repairs which are likely to result upon each individual system.

With regard to the first point, it is not generally recognised what amount of expenditure is justified in converting horse tramways to mechanical traction.

What expenditure is warrantable upon introducing a system which can even only show a saving over the old system of 1*d.* per car mile run.

We will take as an illustration a town system in which it is desired to have a good service of cars, such as 1000 car miles per mile of double track per day, and experience shows this is to be quickly attained with cable haulage, which fosters, and can afford to foster, a tramway business in a way which no other system can.

One thousand car miles per mile of double track per day, with a mean car speed of 6 miles per hour (which is, of course, low), would require for working a day of 17 hours, an average interval between the cars of say two minutes, 10 cars thus running on the mile of street length, and performing 60 car miles per hour.

This would give 365,000 car miles per mile of double track per annum, and 1*d.* per car mile saved would be in round figures 1500*l.* per mile of street per annum. That sum is sufficient to pay 5 per cent. interest on a capital of 30,000*l.* per mile of street, and yet it is only 1*d.* saved per car mile.

Cable-haulage for such a service would be about 4*d.*, and would probably be nearer 5*d.*, per car mile cheaper than the present expenses for horse traction.

And yet there are people who still hesitate, and some even refuse, to consider mechanical forms of traction where the initial cost is high, and therefore never discover the extraordinary results and savings which may be effected in the future by the expenditure of additional capital at the right time.

With regard to the second point, the Author would like to draw your attention to the class of figures which you have to guard against.

In a paper lately read before the Institution of Civil Engineers, the costs of maintenance and repairs on an electric tramway line were given to four places of decimals as follows.

For the maintenance and repairs of cars, with motors and everything complete, ·26725*d.* per car mile run.

The Author ventures to say that nobody will dispute that the cost of maintenance and repairs for heavy cars, with heavy motors and electrical machinery, must in the future cost far more to maintain than the ordinary horse car, and yet it can be most conclusively shown that the average cost of maintaining a horse car only in Edinburgh during 11 years has been ·51*d.* per car mile run, or twice the figure which is quoted for electrical maintenance.

Again, it was also stated that the cost of maintenance and repairs for lines, which would include the whole of the permanent way, rails, bonding, electric poles and wires, etc., was ·0088*d.* per car mile run. Experience shows that the average expense of maintaining the horse tracks alone in Edinburgh has been during 11 years ·64*d.* per car mile run, or nearly seventy-three times the amounts given for maintaining electrical road and wires, etc., etc.

The Author does not wish to infer that these figures are put forward to wilfully mislead, but he cannot too strongly warn those who are seeking for information, that a few such items in the cost of maintenance would make the difference between financial success and failure. The cost of maintenance can only be properly arrived at when the fullest data of working is available over an extended period of time.

The whole of the work is from the designs of the Author and your Vice-President, Mr. Cooper, who are superintending the carrying out of the work with the assistance of their respective staffs.

DISCUSSION.

Mr. F. **Baker**: I should like to mention to the meeting that at Middlesbrough a private company is just putting in tramways extending about ten miles, on this electric trolly system. It may interest some of you who are seeking for information in this respect to come down to see the system, and I am sure I shall only be too pleased to give any Members any assistance and information in my possession. If there are any gentlemen who would like to come down, we shall be very pleased to show them the electric trolly system.

Mr. A. E. **Collins**: I should like to ask the Author whether he has had any experience with the cast weld joint, and whether his experience of it is favourable. I should also like to ask as to cables, whether he has formed an opinion as to the relative values of the ordinary cable lay as compared with Laing's lay.

Mr. Paton: I beg to propose a vote of thanks to the Author. The local circumstances must determine the authority as to the character and kind of tramway which would pay them best. I can quite conceive that with wide streets and a modern town a cable tramway could be laid at moderate cost; but in old towns with narrow streets, where there is uncertainty as to the depth of drains, water and gas mains, &c., it is almost impossible to tell what will be the cost of installing a cable tramway. Personally I regard the cable as the most perfect form of tramway haulage. It does not disfigure the streets, and with a little extra power at the central station almost any number of cars can be put on, while the proportion of expense in relation to income is not the constant figure it is with horse traction. In fact, the greater the number of cars the smaller in proportion is the cost of working. In Edinburgh it is put at 5*d.* per car mile. That, compared with horse traction, shows a considerable saving in working expenses. But it may so happen that in a town where they determined to lay down a cable tramway the initial cost would be such that they would never get a company to pay them 7 per cent. on the capital outlay. The returns would not pay them to do so. That is a consideration, and materially affects the question of the term of repayment which would be allowed for the construction of the lines. If the Board of Trade would only allow a term of twenty-one years, it becomes a serious question what will be the state of the lines on the expiration of the lease. In Plymouth the old system was horse traction, and the company made so bad a job of it that the Corporation ultimately took it over. We are working it by horse traction, and a portion of it is being laid for electric traction. We considered at the time the cable, accumulator and overhead trolly, and after consideration the committee came to the conclusion that the overhead system was the best and cheapest for the town of Plymouth.

Mr. C. Jones: I rise to second the vote of thanks. The paper specially interested me, because we have been fighting a company for six days in Committee of the House of Commons, and I am pleased to say we defeated them. During the inquiry in Committee, some interesting points were raised by Dr. Siemens and Professor Hopkinson in connection with the conduit and the overhead system of electric traction; if anything could have been said as to the merits or otherwise of those systems, it would have been of interest to some of us, and perhaps enabled us to reply to some questions which are sometimes asked us at our Council meetings.

Mr. J. **Lemon**: Will the Author of the paper kindly give the cost per mile of the conversion of the system from the horse tramway to the cable tramway. The capital charge, including everything. I do not think it is in the paper; if it is, I have overlooked it.

Bailie Mackenzie (Edinburgh): We have had this matter of mechanical traction before the Council for a considerable time. We did not enter upon the cable system hastily. We looked round and found a number of companies were very anxious to put their resources at our disposal for various systems of electric traction. About two or three years ago we had several companies who were prepared to give every guarantee that within six months they would have a perfect system of underground electric traction installed. But we found there was no system of underground electric traction worth looking at. It is a very curious thing that while in America they are throwing out the overhead electric trolly system, in English cities, in Liverpool, Glasgow, Leeds, they are now going in for that system. Is it the case or is it not, that the Mayor of Chicago has made an agreement with the different tramway companies in that city, that within a certain radius of the centre of the city there is to be no overhead trolly? Is it the case that in Washington, Boston and New York they are throwing out the overhead trolly? It is very curious, and my own explanation is that many large syndicates with any amount of money behind them have made a raid upon the municipalities for erecting electric installations. We made particular inquiry, and on the advice of our expert, as well as from our own knowledge of what has taken place elsewhere, and the uncertainty of many of the electric systems, we decided that we would go in for cable traction. We have seen no reason to regret that decision. We have no doubt that the overhead electric trolly is a fairly good system, but we have yet to know that in such a city as ours, where frequent stoppages must take place, and where the speed cannot by the Board of Trade regulations exceed 8 miles an hour, the overhead trolly system would be as successful as the cable system has been.

Mr. J. **Lobley**: There are one or two things I should like to refer to in the paper. The first is the phrase "car miles." This is rather misleading, because there are cars of very different sizes. Here in Princes Street I have seen single and double-decked cars, and in Boston I have seen cars running which will take three times as many passengers as some of the Edinburgh cars. Therefore the cost per car mile is apt to be misleading unless the number of passengers is taken into account. With respect to New York throwing out the overhead wire, I believe New York never would have that system. I saw them laying the cable system along Broadway when I was in New York; and there is also the underground conduit system in operation. They have so great a dislike to the large number of overhead telegraph and telephone wires, that they would not consent to have the number increased for tramways. In this they are quite consistent, like Birmingham has been. The overhead trolly system has, I think, many advantages. In my own town we are now in the throes of a reconstruction, having over 2 miles of streets up for converting to electric traction and extension. I do not think after twelve months' experience that any one takes the slightest notice of the poles and wires in the streets. Notwithstanding the advantages of the overhead trolly in cheapness and efficiency, I should prefer the cable system if I could possibly have it. The roads are very crooked, and we have a large number of canal bridges, the crowns of which are not more than 12 inches above the soffits of girders, and which require to be constantly raised, owing to undermining. I have not heard that in Boston they have done away with the trolly system; when I was there I saw miles of it at work. In Washington I saw the cable system as well as the trolly, but after all they have been so overdone in America with overhead wires for all manner of purposes that I am not surprised to hear they are desirous of seeing no more of them for tramways.

Mr. **Colam**, in reply, said: I will take the questions asked seriatim. The first point was whether I had any experience of cast weld joints. My objections to the joint are twofold. The joint is of course designed on the assumption that no expansion takes place in tramway rails; I think this is a mistaken notion, especially on curves. My second objection is that you cannot bring two portions of a rail together by a weld, or castweld, without changing the nature of the metal all round where the joint takes place, with a result that unequal wear must take place, and in course of time a hollow place is produced on the rail which must cause a knock on the wheels. It was introduced to make stronger rail joints, made necessary when very high speeds by heavy motors for electric traction became common in America. I use nothing else but the "Laing" lay in the construction of cables, because experience has shown it to be the best for cable haulage. Mr. Paton made some very pertinent remarks, and I thoroughly agree with him, that every district requires to be considered upon its merits. I consider the proper people to discuss the requirements of each district are not engineers but local authorities. The Edinburgh people said what they would not have, and then began to inquire what they could get. I know many districts in this country which could not, in my opinion, give better results financially than with one-horse cars if properly managed. Mr. Lobley makes a remark as to the term "car miles" being misleading. That is one of the disadvantages of not having an opportunity to read the paper. You will see that I give "ton miles" as well as "car miles." Having lived myself in a district where the overhead wire existed, I admit you can get used to it to a certain extent, and the same argument applies to almost everything. The difficulty is if you have to live in a district where four or more roads meet, and cars have to turn to the left and right as well as cross in all directions. In such cases there are so many guard wires, stays and supports necessary that the place becomes a perfect eyesore and source of danger. I should like to direct your attention to the diagram of the Edinburgh tramways, which shows our 47½ miles of lines being cabled, and to ask you what would be the effect of overhead wires through such a district, more particularly in Princes Street and the complicated junctions with it. Then Mr. Lobley refers to the bridge difficulty, and to the fact that he has bridges the crowns of which have only 12 inches cover. We have four cases of that kind in Edinburgh, and they have been satisfactorily got over. Over two of the bridges we have been working by cable haulage for ten years. Bailie Mackenzie put the case against the overhead trolly system, for Edinburgh at least, in a nutshell. It would be a little derogatory for such a city as Edinburgh to take a back seat to Chicago, New York and Washington, which are well known to seldom consider the amenities of their cities, and yet refuse to admit the trolly. This, as I say, is not an engineering question, but for town councils to decide. In America, where they are allowing the overhead wire to go up, local authorities are guarding themselves with a clause to the effect that when they shall be satisfied that they can find a conduit system which is economical, they shall have the power to order the wires down and reconstruction to a conduit system. Mr. Lobley is right in saying that New York would not tolerate the overhead wire. In Boston, the only city in America where narrow streets and congested traffic exists as it does in our country, the overhead trolly system has been put up, and in my opinion it has been a financial failure. Every car costs about ½*d.* per mile run, and it must be remembered that the car mile receipt which is likely to rule in this country is not likely to be more than 10*d.* to 11*d.* The necessary speed for electric traction in Boston has not been possible, and it has been found necessary to divert the car traffic underground, which of course converts the tramway system in the city to a railway.

NOTES ON SEWER VENTILATION AS APPLIED TO WATER OF LEITH INTERCEPTING SEWER.

By ALEX. STEWART, Assoc. M. Inst. C.E.

For a long series of years prior to 1889, the local authorities of Edinburgh had been extremely solicitous about the polluted condition of the river of Water of Leith.

Forty or fifty years ago this river was full of fish life, but by the increase of population and dwelling houses along its banks it had gradually become converted into an offensive and nauseous stream. In addition to this, seven or eight paper and other mills along the banks in the landward district had gradually added the noxious and soda-ley washings and other offensive matters from their several works. This resulted in the accumulation of high masses of froth at the several weirs, and indeed, in certain states of the weather, over the whole length of the river, which caused the stream to be unsightly and nauseous to a degree.

The public authority first thought of repressive legal measures, but engineering forethought came to the rescue, and devised a scheme which has been carried out to the letter, and which, while it has practically restored the stream to its former pristine purity, has also obviated any diminution of water supply to the several mills and works along the stream.

This scheme, which may be of interest to certain towns in England, consisted in the catching up by an intercepting sewer of the various sewage discharges on the way. It also intercepted the mill discharges, where these could safely be put into a conduit, where caustic soda was in use.

Certain depositing ponds were constructed for eliminating the material, which had a tendency to collect in the inside of the pipes, and so to obstruct the sewer.

In order to supply a corresponding amount of water put into the sewer, two reservoirs were increased in storage capacity to the exact equivalent of the waste liquid abstracted from the sewer.

This sewer extends from low water mark at the Black Rocks, Leith, up for some seven miles.

Its total cost was about 350,000*l.*

It has given general satisfaction, however, and fishes are again disporting themselves in the waters of the river.

In the construction of this sewer, street surface ventilators were introduced. Very soon, however, the hot discharges from distilleries and breweries, commingling with the sewage, gave off such nauseous smells, that ventilator after ventilator had to be closed.

Instructions were given to the engineers to report on the best means of ventilating this sewer, because it was held that, although offensive smells were removed from the streets by the closing of the ventilators, there was still risk of sewer gases finding their way into the houses in the neighbourhood.

The erection of tall shafts was considered, but on account of the undulating nature of Edinburgh, which would have necessitated the tops of the shafts being under the neighbouring houses, this scheme was abandoned. The engineers thereafter considered the use of chemical agency in the destruction of these smells and gases.

They opened communication with Reeves' Chemical Sanitation Co., Limited, formed three experimental manholes fitted for the introduction of their chemical apparatus, and watched the result.

These manholes were situated in populous districts. They had, as explained, been closed because of the complaints of smells.

The opening of the manholes and the application of the chemical apparatus was set going. During the months the experiment lasted, frequent observations were taken of the results, and as no complaints were received and the experiment was so successful, the engineers recommended the adoption of the system, and the commissioners entered into a contract for the supply and fixing of other fifty of these apparatus. The manholes have been altered, as shown on the accompanying diagram, so as to allow the apparatus to be placed in a recess clear of the manhole shaft. This arrangement gives free access to men entering or leaving the sewer. These apparatus have been fitted up and have been in operation during the past month, and from careful observations they seem to answer as successfully as the three experimental ones started last year.

It is probable that many of you are unacquainted with the details of this system, and a description may be interesting. Two chemical ware vessels are placed in a recess formed in the manhole. The larger vessel contains a chemical mixture called by the proprietors "Reevezone," and the smaller vessel contains strong clear sulphuric acid. These chemicals are caused to mix continuously, meeting on the ware drip, the result of their mutual reaction being the formation of sulphurous acid gas, oxygen gas, permanganic acid and soda sulphate. These gases purify the foul air they come in contact with, whilst the oxidising solution falls into the sewer and has a beneficial effect on the sewage. The water supply for mixing the Reevezone is taken from the water main. Where it enters the manhole a drop stop valve is fixed to the pipe which, when the pressure from the main ceases, closes, and so entirely prevents air being sucked into the main. There is also another valve and a syphon of water about 3 feet deep, which completely locks the pipes against any back pressure. Beyond the syphon a branch pipe with valve and spray is fitted, the discharge of the spray being thrown on to the three pots on which the chemicals fall, after the gases are given off. The result of the water striking against the pots is that a fine spray or mist of the chemicals is produced, which in falling into the sewer purifies the gases coming up the shaft.

When the apparatus were first started, a number of tests were made at the various manholes to determine the amount of air leaving or entering the sewer. The dates on which these tests were made were 30th and 31st May, 1898, and from the following table it will be noticed that the results give a curious condition of ventilation.

The lowest record is in London Street (east end), which showed 62 cubic feet per minute leaving grating; and the highest is from the grating in Doune Terrace, which registered an outlet of 3425 feet per minute, pointing to the necessity for further ventilation of the adjoining sewer. At this time a slight smell was observed, which showed that the volume of gases was greater than the chemicals can purify. Undoubtedly the temperature of the trade refuse discharged into the sewers is one of the chief factors in producing this extraordinary movement of air.

OBSERVATIONS AND READINGS OF THE VENTILATION OF THE SEWERS OF EDINBURGH AND LEITH ON MAY 30 AND 31, 1898.

Name of Street.	Inlet, feet per minute.	Outlet, feet per minute.	Weight of Air at Road Surface, grains per cubic foot.	Weight of Air in Sewer, grains per cubic foot.
London Street, East End	..	62	542·06	542·06
" Cochran Terrace	..	418	544·06	542·06
Mansfield Place	..	496	544·06	542·06
Comely Bank..	..	186	551·36	545·53
Great King Street	..	837	536·16	542·06
Doune Terrace	..	8425	536·16	542·06
Moray Place	415	..	526·16	538·60
Nelson Street..	..	739	532·84	536·33
Dundonald Street..	310	..	537·45	537·45
Great Stuart Street	..	1317	535·16	534·00
Randolph Crescent	310	..	535·16	539·75
Melville Street	..	992	535·16	538·66
Walker Street, opp. William Street	..	872	532·84	538·66
Walker Street	930	..	535·16	538·66
Chester Street	992	..	535·16	536·30
Rothesay Terrace	..	744	535·16	536·30
Palmerston Place	..	186	535·16	536·30
Eglinton Crescent..	..	872	535·16	532·80
Comely Bank (West)	186	..	551·36	545·53
Raeburn Place	737	..	546·89	545·53
Deanhaugh Street	..	446	544·36	539·75
Ann Street	..	1320	539·75	537·45

Some time ago experiments were made on the temperature of the trade refuse discharged into the sewers, and the highest temperature reached was 135° Fahr. When operations were being carried on in the intercepting sewer in James Place, Leith Links, which is about 925 yards from mouth of outfall, on the 14th June, it was found that the temperature of the air in the sewer was as high as 75°, whilst that on the surface was only 60°. This shows the difficulties met with in dealing with sewer ventilation in a district where trade refuse is allowed to freely enter the sewers.

From the results given in the table above, and from other observations, Mr. Reeves suggested to the engineers that these results were produced by the wind and tidal action at the outfall, and proposed to cut off the gases at the highest point to which the tide rises in the sewer, viz. James Place, his idea being to purify and wash the whole of the gases in this length of sewer, and prevent the gases above the tidal level being forced up into the city by the action of the tides. The process suggested is as follows. A chamber would be built at the highest point to which the tide rises. The air space above the sewage would be shut off by a floating trap, and the sewer air, displaced by the rising of the tide, washed through the chemicals as shown on the diagram, the purified air escaping through the gratings. Whilst the tide was ebbing and the sewage returning to its normal flow, the air space would be filled with fresh air at each tide. He also suggested that a second purifying apparatus should be fixed at the base of the shaft nearest Leith Links.

An experimental trap has been placed at the point suggested, and the tidal action on the air of the sewer is entirely removed, and the result of observation taken at the grating where the trap is situated, shows that the inlet exactly corresponds to the vacuum caused by the lowering of the sewage.

The following is a statement of the cost of introducing the fifty-three apparatus.

	£	s.	d.
3 experimental apparatus at 15*l.*	45	0	0
50 apparatus, as per contract, at 10*l.*	500	0	0
Altering 53 manholes to suit apparatus, at 7*l.* ..	371	0	0
Total cost	£916	0	0

The company have contracted to provide the necessary chemicals for manholes in series at the rate of 2*l.* each per annum, and for detached manholes the charge is not to exceed 3*l.* per annum. The company are under obligation to deliver chemicals here and maintain constantly a sufficient supply for three months in advance.

Facilities will be afforded any gentlemen desirous of seeing the system in operation, and comparison may be made between manholes fitted up with the apparatus and those which are not.

DISCUSSION.

Mr. J. Lemon: I have very much pleasure in proposing a vote of thanks to Mr. Stewart. The paper raises a very important question as to how far manufacturers and others are to be allowed to discharge noxious refuse into a public sewer. I have had to deal with the liquid refuse from breweries where the quantity has been one-third of the total sewage, and I need not tell you under such circumstances the sewage was very difficult to deal with. I was of opinion, and we took legal advice upon the matter, that brewers and others who committed this nuisance should be compelled to purify their refuse at their own works before discharging it into the public sewer. It appears here the local authority have been put to the expense of 350,000*l.* for that intercepting sewer which has been brought about by paper mills and other manufactories, and I cannot see the justice of that expenditure. I suppose there were local conditions which actuated them of which we know nothing. With regard to complaints, you sometimes get complaints of smells from manholes which never exist except in the imagination of those who make them. I had a case of a gentleman who was a chemist, and who made a complaint about a manhole opposite his house, and he persuaded the health authorities to put in some charcoal trays. The charcoal trays were put in, but the charcoal did not arrive. The next time he met me, he said, putting his nose close to the grid, "that charcoal answers admirably." There was not an ounce of charcoal in it, and I do not believe there ever has been.

Mr. A. D. Greatorex: I should like to refer to a similar experiment which I was the first to carry out at Sutton on the same system as at Edinburgh. About five years ago we introduced this system over the entire area of the low-level sewers, and watched it continually, and I must say we never had any complaints during the whole of the time it was in operation. Following this experiment I was induced to make some investigations as to the efficiency of ventilating sewers by columns and up-cast shafts, and the result of my investigations, as published in 'The Surveyor,' of October 1894, was to show that that system of ventilation is a mistake. I found, in the course of my experiments, that the majority of these so-called ventilating columns did not act at all; in fact, in some cases, the air was coming out of the inlet instead of the outlet of the ventilating shaft. We had two complaints at Sutton, where sewers did smell very badly. I persuaded the District Council to take down the two ventilating columns and to put on a similar apparatus to that which we had on the low-level sewers, and then we had no further complaints, proving that the apparatus was a success. Mr. Lemon has referred to an imaginary complaint which was made about smells from a sewer. I remember a somewhat similar complaint of smells from a sewer at Sutton, at a point where five roads met. To prove that the complaints were merely imaginary, I instructed one of my men to stop up the outlet during the middle of the night, leaving the surface of the road as before. The complaints still continued to be made, and I allowed them to go on for some little time, when I told the person who complained that the ventilator had been done away with from a certain date, when the outlet from it was stopped up. From that time we had no further complaints, showing that the grievance was a purely imaginary one. I am of opinion that the proper way to deal with sewer gas is to entirely destroy it, or to deodorise it in the sewers themselves, and not to bring it to the air to pollute and poison the surrounding neighbourhood. I think until engineers make up their minds that that is the proper policy to pursue and follow it, the death-rate will not be reduced to the extent it would be if that policy was carried out.

Mr. F. Baker: I have very great pleasure in supporting the vote of thanks to Mr. Stewart for his excellent paper, and should like to ask one or two questions with respect to this question of sewer ventilation, which is a very important matter to those of us who live in towns situate on tidal rivers. I know it is with us in Middlesbrough, where we are very much troubled at times with smells from the sewers. I should like to ask with respect to dealing with trade refuse, whether they have any galvanising works in Edinburgh, and if so whether refuse of that description finds its way into the sewers. I should also like to know whether, now they have adopted this system, the grids at the manholes in the streets are closed or open, and whether they have any up-cast shafts on the sewers or any mechanical means for extracting the air from the sewers?

Mr. J. S. Pickering: Mr. Stewart does not mention in his paper the quantity of sewage he deals with by this process, and if he would give the information it would add to the value of the paper. I notice that it is necessary to utilise water from the water mains in connection with this system. It would be interesting to know the quantity of water used and the cost per million gallons of the sewage dealt with, so that we may have some data to go upon as to the cost of the system. As a rule I think these processes of sewer ventilation which require mechanical aid are not to be preferred if something can be obtained which is more simple and will require less attention. At Nuneaton we require all makers of new streets to erect ventilating shafts for the ventilation of the sewers, and we find them very useful. The street gratings usually act as air inlets and the shafts as foul air outlets, and we have very few complaints of smells from the sewers. Another process which has been brought before the Association is the Keeling Sewer Gas Destructor, for the destruction of sewer gas by the consumption of coal gas. We have some of them at work, but in speaking of them I can go back to the remark I made at the outset, that all these systems of ventilation which require a good deal of attention are things to be avoided if possible. If the gas flame of the destructor goes out the system of ventilation is a failure, and I do not think there is an engineer who has put up these gas destructors who has not found that the flame becomes extinguished at times, and the sewers of the district are then left altogether unventilated.

Mr. S. S. Platt: It seems to me rather strange that you have no power in Scotland to prevent waste liquids being put into the sewers at this exceedingly high temperature. In England the highest temperature at which waste liquids can be discharged into the sewers is 110° F. Sewer ventilation, like other systems of ventilation, requires human agency to adapt it to the variable atmospheric conditions, and for that reason I doubt if any automatic system will be satisfactory under all conditions.

Mr. Smith-Saville: With reference to the remarks o Mr. Lemon as to the injustice from trade refuse being received in sewers, I may say that I was once connected with a town where a flow of sewage equal to six times the ordinary flow, was received daily, the excess being entirely due to brewery refuse, which in process of fermentation set up very vile smells. In these circumstances you will readily understand that the complaints we received of smells from the sewers were very excessive. Owing to the slow gradients and the bad state of the sewers, the result was that we had to reconstruct the sewerage system, entirely on this account, and to lay out a farm of 500 acres for the treatment of the sewage, altogether at an extra cost of something like 200,000*l.* Mr. Platt says we have power to prevent the discharge of trade refuse into the sewers above a certain temperature, which is quite true, but you all know where you have a staple trade to deal with, powerful enough to dominate a town, you cannot carry out the law, and we frequently have refuse water discharged into the sewers at a temperature of 212°. We tried one of the sewer gas destructors spoken of by Mr. Pickering, but we found its influence to extend only over a very limited area, and the light very frequently went out. It was introduced because of complaints received of smells from the sewers at this point. After a while we ceased to trouble further with it, and I may say that notwithstanding this we never had any complaints afterwards at that point, although it was not working, but of course the residents in the vicinity did not know of this.

The President: I have no desire to enter into the discussion of these papers, but I cannot help making a few remarks as to ventilating sewers by means of up-cast shafts. I have ventilated upwards of 50 miles of sewers on that system with absolute and complete success. I have been careful to take tests throughout the year, and shall be pleased to let any Member have those tests. With regard to the Keeling Sewer Gas Destructor, I found on experiment that I was getting a better velocity with an ordinary up-cast shaft than with a Keeling destructor.

Mr. Lemon: That is my experience exactly.

The President: It was very expensive, and altogether unsatisfactory. As I am keenly interested in this question, I was anxious to make those few remarks.

WORKING OF THE HOUSING OF THE WORKING CLASSES ACT (1890) IN EDINBURGH.

By WILLIAM BRUCE,
Graduate of Assoc. of Municipal and County Engineers, and Mem. San. Inst.

The fair face of the City of Edinburgh has been so often extolled, its many advantages and beauties so often commented on and admired by strangers, that any one not acquainted with the city might be led into the belief that in this favoured community there was no seamy side to life at all. Until recent years, the changes and improvements ever taking place had for their object more the increasing of the beauty and convenience of the city at large than the promoting of the welfare or interest of any particular class. But as these changes and improvements were mostly effected on the older parts of the town, in our appreciation of what had been accomplished we were inclined to overlook the fact that all these clearances and street widenings must have been accompanied by a measure of inconvenience and hardship to a large number of persons.

It is said that by the Improvement Scheme promoted by Dr. Chambers, Lord Provost of the city some thirty years ago, that about 14,000 persons were removed from their houses. At that time many old landmarks were swept away; whole streets, closes and wynds being obliterated to give place to what are now spacious and thriving thoroughfares.

The advantages and benefits of this scheme are acknowledged, and its good effects in bringing light and air into the midst of darkness and disease are visible to-day; but it is also a question if the present scarcity of small houses in Edinburgh, with the accompanying high rents, does not date from that same time. The improvements effected in more recent times, although not so extensive as the one just mentioned, have all brought with them their quota of hardship and discomfort to some poor people. The other causes, economic, social or otherwise, which conduce to overcrowding and congestion in the poorer parts of all large cities, it is not within the province of this paper to discuss; but these causes have been active here as elsewhere, and in this city the facilities afforded by the closely built and lofty tenements of the old town for crowding together a large number of persons on a small area are altogether exceptional, and for long have stood a constant menace to the whole city.

The clearing away of much of this old property without making any suitable provision for those unhoused, only drove the poor into other quarters, and to meet the demand for small houses, tenements originally intended for and occupied by a class that could even lay claims to gentility, were sublet and subdivided until what was originally a house of five or six apartments became occupied by as many families. In these large blocks, with flat raised upon flat, this subdivision, as can be realised, resulted in much overcrowding, with all the attendant evils to health and morals.

A common feature, and indeed almost a rule in this class of tenement, is to have all the houses on one flat, to the extent sometimes of ten and more, entering from one common lobby running along the centre of the block, without any light but what is derived from one doorway communicating with the common stair, and with only the doubtful ventilation gained by the occasional opening of a house door. Into this lobby were compounded all the smells from the various houses, besides being the chosen position for the w.c., sink and supply cistern common to several families.

Under conditions such as these, physical and moral degeneration is all that can be looked for or expected, and against this class of tenement the Public Health Committee have waged constant and unrelenting war, and have exercised their powers of compelling owners to introduce suitable sanitary accommodation and effect other improvements; but it was ultimately felt that something more drastic and sweeping must be accomplished if the evils of this system of subdivision were to be successfully combated, and amelioration effected in the condition of the numerous class whose lot was cast in these congested and unhealthy areas.

With this object in view, the Corporation of Edinburgh applied for, and obtained in the year 1893, a Provisional Order for a scheme under Part I. of the Housing of the Working Classes Act, 1890. This scheme embraced ten areas situated in different parts of the city, ranging from about one-tenth of an acre to about two acres in extent, the total areas scheduled amounting to about 6½ acres, with a population of nearly 10,000 persons. With the exception, perhaps, of individual properties here and there, all these areas have been acquired by the Corporation at a cost of about 70.000*l.* In some cases these areas have been entirely reconstructed; others have been wholly or partially cleared of the old properties, while some remain untouched as when first acquired. The actual number of persons unhoused by the Corporation in carrying these improvements into effect was about 2700.

It is unfortunate that, concurrently with the undertaking of the Corporation, the North British Railway Company should have entered upon a large scheme for the enlargement and reconstruction of the Waverley Station and approaching lines, which embraced the destruction of a great amount of property tenanted by the very class for whose betterment the Corporation were labouring to improve; and that the additional evictions by the Railway Company of about 460 families caused great hardship and inconvenience among the labouring classes.

So great had the demand for small houses become that the Corporation had not only to stay their hand in the work of clearing out the slums, but had to reinstate many families into their homes, and rehabilitate many houses that had been partly dismantled, in order to avoid any unnecessary suffering, and until such times as better housing accommodation could be provided.

While it is often too easy a matter to be able to put one's finger on the plague spots of a city, and to effect sweeping clearances, it is only when the question of rehousing the displaced population arises that the real difficulty is confronted. Knowing the number of families to be accommodated, the first question is, naturally, what class of houses should be provided? To settle that they ought to be on the principle of cottage homes, flatted tenements, or anything else, does not sufficiently answer the question without first deciding what class of poor it is intended to cater for. There are some poor who only wish the conditions and opportunity to enable them to lead orderly and exemplary lives; while there are others (and these, unfortunately, constitute a large factor to be reckoned with) who can only be dragooned into order, and who would require that supervision be extended into the inmost arrangements and workings of their homes.

To the first may be entrusted a house with all sanitary conveniences private to itself; but for the second, who might not scruple to abuse any advantage or privilege, it might be better to have all sanitary appliances and such like under the control of a vigilant caretaker; and in any case, to bring these two classes together indiscriminately would result in injury and injustice to the one, with probably no counterbalancing advantage to the other. Up to the present time, it may be said that anything the Edinburgh Corporation have done is for the benefit of what may be called the respectable poor, and it is to be hoped that they will yet do something to meet the requirements of that class whom we are inclined to regard as incorrigible and thriftless.

The sites selected for the erection of the new workmen's dwellings were two in number: one in Cowgate, in the centre of the city; the other at Tynecastle Meadows, a working-class suburb.

Tynecastle Meadows was not an area scheduled under the Housing of the Working Classes Act, but the land had been acquired by the Corporation, and it was thought that the erection of suitable houses here might relieve congestion elsewhere.

In Cowgate there have been provided 24 houses of one apartment, and 32 houses of two apartments, each house having its own w.c. and sink.

At Tynecastle there have been provided 21 houses of one apartment, 16 houses of kitchen and bed-closet, and 24 houses of two apartments; and here the w.cs. are common to two families.

At Cowgate the area available for the new houses, after conceding a part of the ground to street widening, was so limited, that space could not be afforded for washing-houses or bathrooms, but from the immediate proximity of the public washing houses and baths this was not considered a serious drawback; at Tynecastle, however, there is a wash-house and bath-room common to every four tenants.

The houses erected on both sites are in flatted tenements, on the balcony principle.

The staircases are under cover, but have their entire fronts open to the outside air. In the Cowgate scheme each house is through-going from front to back, with the doors opening to the balconies, and as far apart as planning will permit; all walls are plastered, with the internal angles rounded to prevent lodgment of dirt and to afford facilities for cleaning. Owing to the great difference in level between the ground at back and front of these tenements, it was found necessary to construct the entire ground floor as shops, which added to the cost and rather handicapped the scheme.

The cost of the two Cowgate blocks was 10,000*l.*, and the Tynecastle blocks about 8700*l.* Owing to the inequalities of level already referred to, the amount of excavation necessary, and the retaining walls required before the site in Cowgate could be utilised, no charge for land is made against this scheme.

At Tynecastle the land may be valued at 500*l.*, which makes the entire cost of this scheme 9200*l.* for land and building.

The rentals for these Corporation houses are:—

At Cowgate, houses of one apartment, 2*s.* 7*d.* per week; houses of two apartments, 4*s.* per week.

At Tynecastle, houses of one apartment, 2*s.* 4*d.* per week; houses of one apartment and bed-closet, 2*s.* 10*d.* per week; houses of two apartments, 3*s.* 3*d.* to 3*s.* 8*d.* per week.

The tenant's proportion of local rates are included in these rentals, with the exception of poor and school rates, which run about 6*d.* in the £; and it is estimated that after paying interest on capital, burdens and maintenance, the balance put into a sinking fund would pay off capital expenditure in about thirty-three years.

These results are not much in excess of what is being paid in those dilapidated and insanitary houses already referred to. It may be quite possible to provide houses at a lower rent than those charged by adopting a different principle of construction, but we must not sacrifice any sanitary advantage to the question of cost.

Among sanitary authorities, back-to-back houses stand condemned, but the Author believes that those who have studied the question will agree that through-going houses are less economical of space, and therefore more costly than back-to-back houses.

This is especially the case if one- and two-roomed houses are mixed in the one block; either the single-room house must be entered by a long lobby, or the room must be unnecessarily large; and when, as in Cowgate, each house of one and two apartments is provided with its own w.c. and sink, the effect on the cost becomes apparent. That houses with these advantages, however, are highly appreciated and much sought after, is evident from the fact that for the Corporation houses in Cowgate alone there are about twenty applicants every week seeking to be accommodated.

It may be generally accepted that for any housing scheme of the nature of those under consideration, supervision more or less stringent must be exercised if the property is to be prevented from entering on a downward course of dilapidation almost as soon as occupied. The amount of evil which a few unruly and worthless tenants can work is incalculable, and in all cases where the size of the scheme will permit, a resident caretaker should be provided. Fortunately, in some respects, but unfortunately in this, the schemes so far carried out in this city are small ones—too small to be burdened with the cost of a caretaker; but recognising the necessity for supervision, the Corporation have handed over the factoring of those properties to the Edinburgh Social Union—a body whose object is to promote the welfare of the labouring classes, and to provide them with suitable and healthy houses at a low figure. The rents of the properties owned and factored by the Social Union are collected weekly by its lady members, who in many matters pertaining to household affairs exercise a wholesome influence over the tenants, or reprove any infringement of their rules with more tact and less offence than a man might be able to do.

Among the many applicants for these Corporation houses, no selection is made; each is accommodated as vacancies permit, but non-conformity with the rules, especially on the score of uncleanliness, is not tolerated unless amendment is made; and further, as showing the class of tenants occupying these houses, it may be of interest to state from information kindly supplied by the Social Union, that the weekly wages earned run from 7*s.* 6*d.* (in one case), up to 29*s.*, the weekly average being 18*s.* to 22*s.*

In addition to the houses built by the Corporation, the North British Railway Company have erected 74 houses to partly accommodate the working-class population displaced by them in the extension of their station. The Social Union have effected great reformation in remodelling and reconstructing several old tenements in the centre and crowded parts of the city, while there have also been several excellent examples of working men's houses provided by private agency; but these isolated examples of what *can* be done only serve by comparison to bring more into prominence how much yet remains to be accomplished.

Not satisfied with what they have recently undertaken, the Edinburgh Corporation have again, this year, applied for powers to deal with other seven areas under the Housing of the Working Classes Act, embracing an area of nearly five acres. Three of these areas are in Portobello, recently amalgamated with Edinburgh, and other four in the Stockbridge district in the north-west of the city, and here we may shortly expect a new condition of things, and an important housing scheme for the poor of those parts.

But the field for improvement is a large one. Other areas and districts in the city are fast lapsing into a condition (if they have not already reached that stage) when only thorough and comprehensive treatment by our local authority can root out the evils hidden in their depths. The work can be surmounted if resolutely faced, and if spasmodic and intermittent efforts give place to something at once systematic and sustained; but its execution will be sufficient to tax the resources of our councillors, and will afford scope for the ingenuity of our Municipal Engineering Department.

DISCUSSION.

Mr. C. Jones: I have much pleasure in proposing a vote of thanks to Mr. Bruce for this exceedingly interesting and valuable paper. This question of the housing of the poor is a permanent one, "for the poor we have always with us," and the information contained in the paper is of the utmost importance. I am sure Mr. Bruce has done good service in bringing this question before us in so clear and explicit a manner.

Mr. A. H. **Campbell**: I should like to ask a question with respect to these one-room dwellings. I know a good deal about the social conditions of Edinburgh, and I wish to know if there are any restrictions as to the number of persons who shall occupy these one-room dwellings. I should also like to know whether there is any limitation of the number of persons who shall occupy the two-room dwellings. I notice that the 10,000*l.* Cowgate block works out at 180*l.* per dwelling; and the cost of the Tynecastle block at 217*l.* per tenement. That appears a rather high price for houses of such a small character. We are accustomed to erect a 3-, 4- or 5-room dwelling for a cost of 200*l.*; cubing out at 4½*d.* per foot.

Mr. W. H. **Savage**: It would be interesting to know how this scheme works out financially after taking into account the cost of area cleared, and payment of interest and sinking fund, and allowing for rents received, and whether it pays the Corporation the 7½ per cent. interest on outlay of which we have heard in connection with another scheme. It hardly seems a proper thing to me to have dwellings consisting merely of a single room, as it is hardly possible for families to live with decency under such conditions.

Mr. C. F. **Wike**: I am rather doubtful if large blocks of dwellings of this description would be appreciated by the working classes of the large provincial towns of England. The Sheffield Corporation are clearing a densely populated area of about 5 acres, under the Housing of the Working Classes Act, 1890. The population of the insanitary area was about 1200, and the estimated cost of the purchase of the property and the construction of new streets for the development of the area is about 80,000*l.* The Corporation of Sheffield are considering the most effectual way of providing accommodation for the persons who will be disturbed. It has been decided to offer premiums for the erection of model dwellings on one section of the site, and also to invite landowners to submit offers of land in the suburbs adjoining the tram routes. The number for which it is intended to provide on the area itself is about 700. It is considered by some that working men in the provinces are rather averse to living with a number of other families under the same roof, and prefer having their own house and not losing their individuality. Partly for this reason, and also because it was desired to relieve the congestion in the centre of the city by spreading the population into the more open districts, the idea of houses in the suburbs had been considered, and it was thought that by aid of cheap tram fares it might be possible for working men to have cottages away from the centre of the city, with small gardens attached, at low rents. The extension of the tramways, and adoption of electric traction and cheap fares, was looked upon as a very important factor in the scheme. Of course the land in the suburbs is cheaper than that in the town, and this will help in the matter of rent. Some time ago, in consequence of the carrying out of a street improvement, the Corporation had to provide a number of tenements to replace others demolished. Land was secured within a quarter of a mile of the improvement, and four-roomed cottages, with separate water-closets and yards at the rear, were erected upon it. The restrictions of the Local Government Board as to the manner of carrying the scheme out were very severe, but notwithstanding, the cottages are paying 3½ to 4 per cent., including the cost of the land. The houses demolished were three stories high, and had originally been through-houses, but the doorways between the back and front rooms had been built up, thus making each double house into two back-to-back houses. The Local Government Board considered these as two houses, and the number of new houses to be provided was fixed accordingly. Some of the single houses accommodated two families, and as the new houses were of a much superior kind the families evicted could not afford to live in them, consequently they are occupied by a very different class than that for which they were intended.

Mr. YABBICOM: I should like to ask Mr. Bruce whether the amount stated here includes the purchase of the land or is only the actual cost of the building. I notice that the two Cowgate blocks, erected at a cost of 10,000*l*., will make provision for 88 tenements, accommodating, at two persons per tenément, 176 persons, which works out at 56*l*. per head; this is rather a high price. I am very much interested in the subject at present, because I am preparing a scheme in Bristol for housing the working classes.

Mr. E. P. HOOLEY: I should like any one who is interested in artisans' dwellings to visit Nottingham, and look round at what has been done in that city. I think the beautiful and artistic buildings which were erected by the Town Council in Nottingham should serve as an example and a warning to any city that is thinking of carrying out a similar scheme. Over twenty years ago the Town Council spent many thousands in erecting huge model dwellings—one of the blocks never (to my knowledge) had a single soul in it, and has now been pulled down. A scheme on the lines suggested may do for Edinburgh, where possibly people are accustomed to living in one room; but Englishmen do not like to herd together in "model" dwellings. I have heard it said on all sides that the great difficulty in properly dealing with this question is the cost. But when you consider that the Lunacy Commissioners are compelling us to spend 200*l.* a bed on lunatics, the Local Government Board ought not to object to others spending 200*l.* to 300*l.* a house on providing decent tenements for sensible people to live in.

Mr. R. A. MacBrair: At the present time we have a scheme for artisans' dwellings before the Local Government Board, and it has been in their hands for nearly six months. After they had had the scheme for three months they returned it, saying unless certain alterations were made in the plans they would not consider it. They objected to the passage between the houses. They also required that there should be a fireplace in every bed-room, and they insisted upon every wall dividing two houses being 9 inches in thickness. In one case, the length of the street was 3 feet beyond that requiring a certain width according to the bye-laws, and they insisted upon our widening it a further 5 feet. A further stipulation was that the staircases of the houses should be ventilated. Then they also asked for a certain number of manholes on the sewers in the street. I altered some of the details of the scheme to partly meet their requirements, but was unable to carry out all their suggestions. The plans were then returned to the Local Government Board, and at last they sent word they would hold an inquiry, but we have not had it yet. It would almost appear, from the restrictions they seek to impose upon us, that there is not an overwhelming disposition at the Local Government Board to help on schemes for the provision of artisans' (or rather labourers') dwellings. When I returned the plans to the Local Government Board I said that, if all their suggestions were insisted upon, no doubt the Corporation would reconsider their decision and not build the houses at all, as the cost would be so increased as to render it impossible to build to let them at rents payable by labouring men, the class my Corporation desire to provide for. The Corporation do not wish any concession from the Local Government Board which they do not regularly allow the local builders.

Mr. Paton: I consider the Local Government Board was perfectly right in insisting upon local authorities showing regard to and carrying out their own bye-laws. The local authority should set an example in this respect, and we have no reason to object to the Local Government Board taking up that position. In Plymouth we are going to displace 800 to 1000 people, and the Local Government Board compels us to buy land in the outskirts of the town to build houses to accommodate these people. That does appear to act harshly upon the local authority if it is insisted upon to the letter. People are displaced from the densely-populated portion of the town, but we find artisans going to occupy the houses which are intended for the displaced population. In Plymouth we are clearing 3½ acres, with a population of 1000 people. It is an old part of the town, with streets 18 feet wide, and after pulling down the houses and widening the streets we can only provide for 500 people, so there will be nothing unreasonable in asking to provide houses for the remaining 500 people in the suburbs. The houses are on two floors, and each floor is a separate tenement; and the only difference is that the tenant of the ground floor has access to the yard. For all practical purpose they are separate houses, and the price cubes out at 4¾*d.* per foot. The rentals we are getting are not sufficient to pay interest on loans and sinking fund, and if that takes place with a scheme on land purchased at 500*l.* per acre, what is going to happen with property in the centre of the town bought at very much higher than its real value? With the 3½ acres the purchase of the property cost us 30,000*l.*, and we estimated that the scheme altogether would cost 70,000*l.*, and in that case there is bound to be a very considerable charge upon the rates. That presents a very awkward problem to a local authority. Why should corporations build houses and compete with the builders out of the pockets of the ratepayers? There was another question which affects the local authority. Where they have a considerable area dealt with in that way the tenants have a very great influence at municipal elections, and when candidates canvass for municipal honours they extort all kinds of promises as to reduced rentals, &c.

Mr. A. J. **Turnbull**: We were the first burgh in Scotland to adopt the housing of the Working Classes Act under the Artisans' Dwellings (Scotland) Act, 1875. We had actually to pay, for 3½ acres of land and buildings, 126,000*l.* for the purpose of getting an insanitary area cleared, and we spent a further sum of 75,000*l.* in erecting dwellings. The scheme has been a very heavy burden on the ratepayers, though a great benefit to the public health. We began with a rate of 3*d.* in the £, and we find, even at the present day, we are compelled to raise a rate of 5*d.* in the £, over and above the rentals we are receiving from the property. Therefore I think we are living in better times for dealing with insanitary areas than we were in those days, as is shown by the heavy rate we are paying for the housing of the working classes in Greenock, compared with the estimated return from the Edinburgh scheme.

The vote of thanks to Mr. Bruce was then accorded unanimously.

Mr. **Bruce** writes, in reply to the discussion: The number of persons occupying the Corporation dwellings is restricted according to the size of the house—in houses of one apartment the occupants are restricted to two adults and two children under twelve years of age.

The rate for building the Cowgate and High School Yards blocks works out at 7*d.* per cubic foot. This seems high for the class of house; but the nature of the site, the fact that every house, both double- and single-roomed, has its own sanitary conveniences, together with the high rate of wages prevailing at the time of building, account for the apparently high cost. I do not know how Mr. Campbell arrives at the cost of one- and two-room houses as 180*l.* and 217*l.* respectively, but he is evidently neglecting the eight shops in the low-level street (Cowgate).

Exception has been taken to one-room houses altogether, and houses of three to five apartments have been spoken of as contemplated by some local authority. Houses of that accommodation in Edinburgh mean rent of 20*l.* to 50*l.*, and are entirely beyond the reach of the class whom the Corporation wish to benefit. In spite of what has been said against the one-room house, there is no disputing the fact that such houses are as much a necessity and would be as much appreciated in large English cities as they are in Edinburgh. One-room houses are provided in many of the Peabody and Guiness dwellings in London, and other buildings of a similar class elsewhere, and who would say they were not required or appreciated, or that Englishmen would not be "herded together" in such houses? These houses of one apartment are intended for, and are mostly occupied by, charwomen, seamstresses, and such like, or by young or old married couples without families and in lowly circumstances. What would be the result of forcing members of that class to take houses beyond their means or requirements? Probably the apartments not required would be sublet, and you would have all the evils of the one-roomed house, with none of the mitigating conditions which may be introduced if the house had been originally planned as a house of one apartment having its own sanitary conveniences.

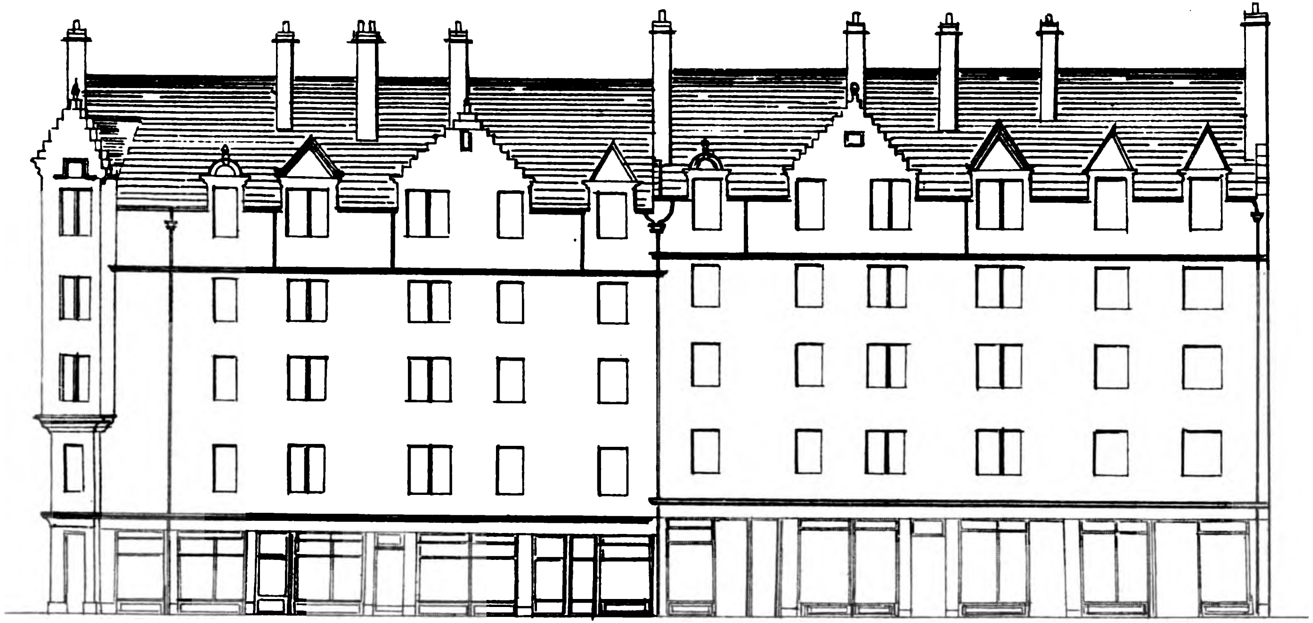
It has been asked if the cost includes the clearing of the areas. The figures given do not include the cost of purchasing old properties, or clearing the ground. One gentleman pointed out that greatly enhanced prices are paid for old properties purchased by arbitration under the Lands Clauses Consolidation Act; and it can well be conceived that in many cases the values of the old properties, where closely built, may exceed the value of the new property by which it may be replaced, and it would be futile to expect that houses built for the poorest class could be rented to pay off such a burden in addition to their own cost and the value of the ground.

With regard to the objections to flatted tenements, local custom and prejudice have much to do with the like and dislike to this class of house. Possibly even a Scotchman would prefer his dwelling to be self-contained, provided it cost him no more than a house or a flat. The whole question resolves itself into one of cost, and where land is at a ransome the houses of the poorer members of a community have to be built one on the top of the other. To transport the working classes to the outskirts of a city, and provide them with cheap railway or tramway tickets for travelling to and from their work, does not make housing any cheaper to the working man, as his tramway or railway fare must be taken as so much added to his rent, and at a minimum would amount to about 3*l*. yearly.

CITY OF EDINBURGH

HOUSING OF THE WORKING CLASSES

COWGATE TENEMENTS

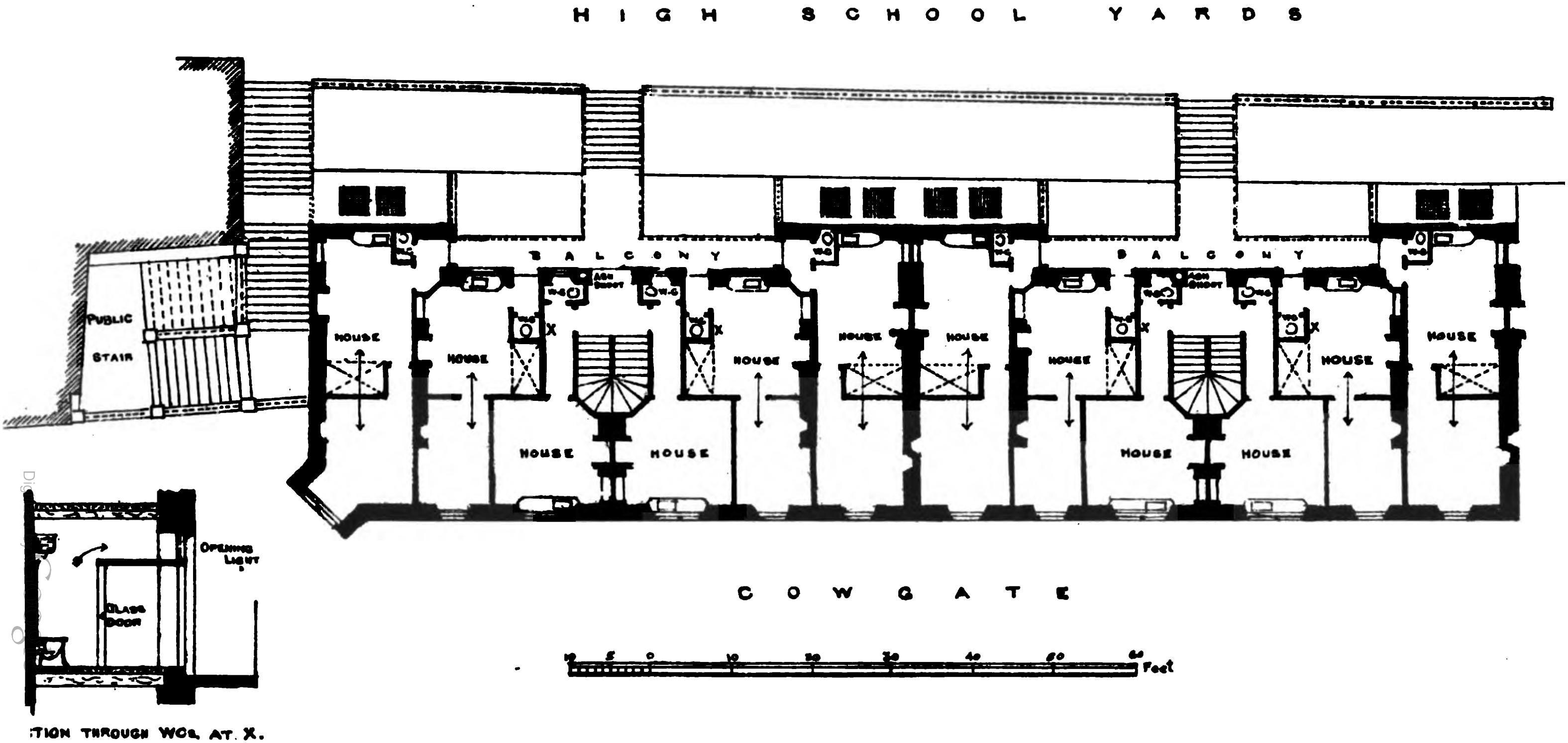


Front Elevation.

CITY OF EDINBURGH

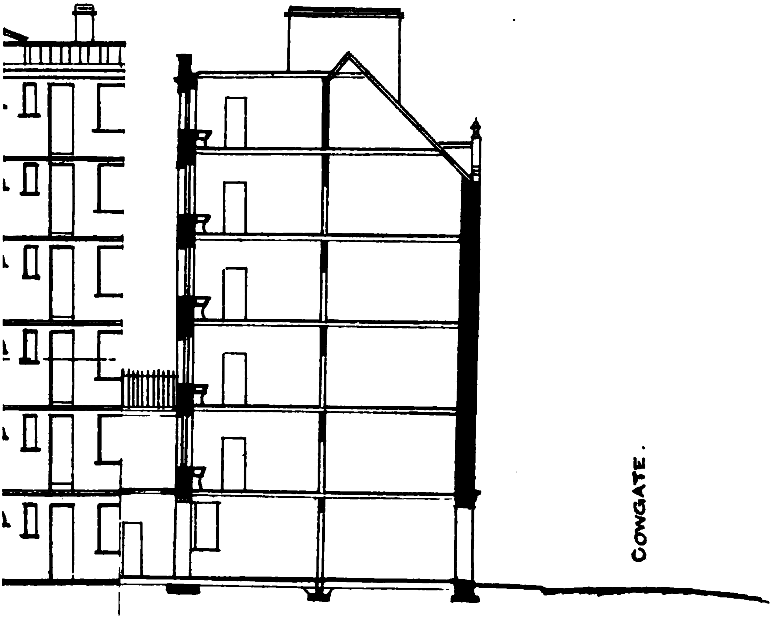
HOUSING OF THE WORKING CLASSES.

COWGATE TENEMENTS.



.ING C

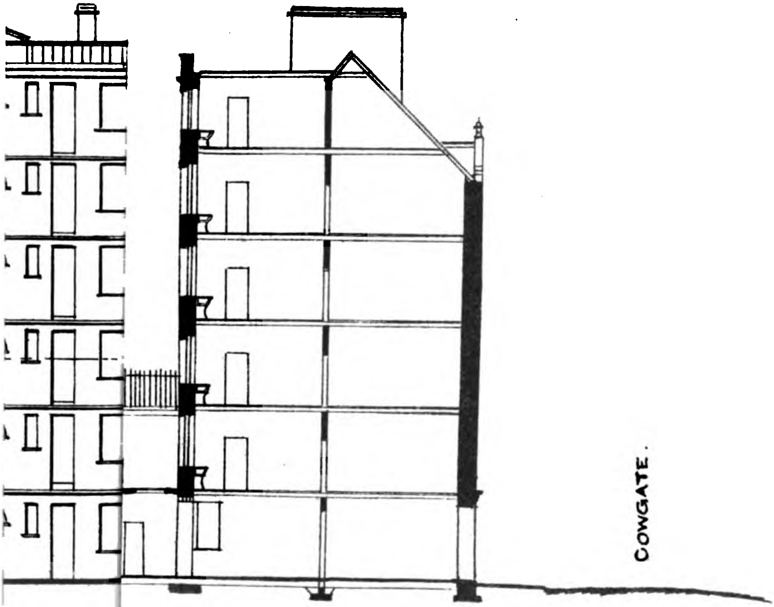
MENTS



Cross Section.

ING C

MENTS



Cross Section.

NOTES ON BACTERIAL TREATMENT OF SEWAGE.

BY DONALD CAMERON, CITY SURVEYOR, EXETER.

IT is but little more than a decade since Dr. Dupré predicted that the future methods of sewage disposal would be mainly biological. The statement received little attention at the time, except from those who thought fit to ridicule the opinion, and it must now be gratifying to the genial Doctor to find the measure of success that has already attended this mode of rendering sewage innocuous, especially now that this form of treatment has obtained a nodding acquaintance with the Local Government Board, and that a Royal Commission has been appointed to inquire into the whole question. The appointment of this commission has no doubt been brought about by the advances in bacterial treatment and the study of the subject, particularly by medical men, in whose domain bacteriology properly lies.

In Britain the work done in gaining a knowledge of the best methods for the disposing of sewage has been confined to individual effort by individuals who could not be expected to combine all the experience or training necessary for providing the conditions required for the solution of the problem, and with us, the law of the division of labour has not been prominent hitherto in dealing with this question; the American experiments have, the Author thinks, shown nothing clearer than the necessity of combined qualified whole-time work in attacking a question of such extreme complexness. The published contributions to the subject in this country are very much like the oft-mentioned map of Africa of our school-days; each contribution forming, no doubt, a survey of part of the whole, but in each case very independent, extremely disconnected and incomparable; and whether the blank spaces are marked "unknown" or not, they are there all the same, and this, in the Author's opinion, is true of the work of each department into which the sewage question could be divided.

It has already, however, been demonstrated beyond a doubt, that, by bacterial treatment,

(*a*) Domestic sewage can be rendered perfectly innocuous and as clear as spring water without the necessity for using a grain of chemicals;

(*b*) That some of the foulest trade sewages in the country are equally amenable to this treatment.

To gain any desired degree of purification, in both cases, is only a question of filtration, after the sewage has been dealt with so as to render filtration practicable. To gain this result, the economy of the system, both in capital and revenue expenditure is, after the experience of recent years, almost incredible, but more especially in the revenue expenditure. In the first place, the cost of precipitation or use of chemicals is removed; and in the second, this purification can be accomplished by a filtering material frequently to be obtained for the cost of removal.

Not the least of the advantages of the bacterial system is practically the removal of the sludge difficulty and the attendant expense. After one year and ten months' working at Exeter, and dealing with a flow averaging 54,000 gallons per day, the tank shows no sign of requiring the removal of the deposit, and the Author is watching with interest how long it will be before any of it has to be removed, as he proposes to work it to its utmost limit. This tank deposit gives the same characteristics now that it showed from the first, that most peculiar to it being its finely divided condition.

For one year and eight months of working there was no provision for arresting the minute particles of the deposit coming away in the tank effluent, and which were deposited on the filter surfaces. There is now provided, at the end of the tank, a channel for the deposit of these particles, and, although not sufficiently long under observation, there is an apparent reduction in the number in the effluent. Obviously the freer from suspended matter the effluent is, the more independent of attention the filter surfaces will be, and that is a condition worth attaining. It is a point gained if works require no attention for days; still more so, when they can take care of themselves for weeks, and the Author has no doubt it is possible to design works that will require no attention for years.

One of the most notable points observed in the Exeter tank has been the hitherto unrecognised energy stored in sewage, as evidenced by the production of marsh gas. With even the limited decomposition which the sewage undergoes the amount of gas evolved has not, the Author thinks, been suspected. The large quantity of matter that must be converted into this condition explains some of the discrepancy shown by analysis.

The permeating power of the gas is another, to the Author, new feature. The concrete arch of the tank is at no place less than 6 inches thick, that being again covered with 9 inches of soil, but the most delicate instruments fail to show any pressure in the tank, and it would appear as if it passed as easily through the concrete and soil as through an open pipe. Attempts to estimate the quantity evolved, by drawing off into gasholders, had, therefore, to be abandoned. Another way of estimating was tried. A metal cone of unit area, provided with an aspirating arrangement, was immersed in the liquid, and it was thought that absolute results could be obtained; but with quick variations, ranging from 150 c.cs. to 4140 c.cs., it soon became apparent that only extended tests would give an estimate of the amount produced. We have thus continued in its products the only constant characteristic of sewage, viz. its variableness.

The works, and public path adjoining, at Exeter have been lit with the gas and incandescent mantles. The Author has not had more than ten such lights burning at one time, but it was apparent, even under the conditions of leakage already mentioned, that more than twice this number could be kept constantly alight, and this estimate was made during the cold wet weather of last winter. The gas is innocuous, and can only be detected ordinarily by applying a light.

The filters at Exeter have undergone another winter's work without any diminution in their powers of purification. As already mentioned, there were no means provided for preventing the humus from passing on to the filter surfaces, but notwithstanding this, the depth of filtrant that has been scraped off since the filters were set to work is less than an average of two inches. The greatest accumulation of humus takes place near the distributing channels, or in the immediate vicinity of the outlet of supply pipes, and curiously enough, the filters with the finest top layer have had less removed than those with coarser surfaces. While the life of a clinker filter must be a very long one, common sense tells us that the less straining it has to perform the longer that life will be, and the less attention the filter will require.

The automatic gear upon which the efficiency of the filters depends has worked without a hitch, entirely dispensing with manual labour.

Although the work of filtration at Exeter is apparently less than at other works, the costly washing of the filtrant is entirely dispensed with, and it is but false economy to provide works entailing heavy annual charges. When it is understood by local authorities that an engineer is justified in expending in capital outlay thirty times any maintenance charge that can thereby be saved, present ideas will undergo a change.

The importance of having complete data of the sewage discharge of any district to be sewered, in which word may be included the disposal works, cannot be too strongly insisted upon. The engineer should have in graphic form the characteristic flows during dry weather, and during different rates of rainfall. This is as necessary for setting that Cinderella of sewage schemes—the storm overflow, so essential and so much kept in the background—as it is for designing the works for disposal. The collection of the necessary data is a tedious operation, but without this one is working in the dark.

In concluding, the Author would claim indulgence for these notes, thrown together, as they have been, when it was impossible to give them the thought and time that a paper for your Association deserves.

DISCUSSION.

Mr. Greatorex: I rise to propose a vote of thanks to Mr. Cameron for the paper which has been read this morning. I am sorry Mr. Cameron is not here to-day to take part in the discussion, because no doubt there are many Members who would like to ask questions upon it. I am afraid at present I could not add anything new to what has already been brought out on this question, but I am in a position this morning to tell you that I have prepared a scheme for dealing with the sewage of West Bromwich at the rate of about two million gallons a day on the identical lines of those at Sutton. The scheme has been adopted by the Council, who decided to have a portion of it put down and give it a trial for six months. Application was made to the Local Government Board about seven or eight months ago, and a week ago the matter had not been decided; but, on the morning I left, a letter was received from the Local Government Board sanctioning the scheme on certain conditions: the conditions are similar to those at Exeter, and provide that the effluent must be run over a certain area of land. They give us seven years for the repayment of the loan, but if in the next three or four years the scheme is a success they will be prepared to increase the period for the repayment of the loan to the ordinary length of time granted for loans on sewage works. That decision is in the right direction, because it shows that the Local Government Board is taking up the question of the biological treatment of sewage, and I think the result of the inquiry by the Royal Commission will be to adopt biological treatment to a large extent. One very distinct point laid down by the Local Government Board is that we shall have no outlet to the stream from my proposed beds, and to make certain that there are no outlets I am to send a detailed drawing showing how the effluent will be taken from the filter. We can congratulate Mr. Cameron on having his large scheme sanctioned by the Local Government Board, even though the effluent has to be run on to the land. In my mind it does not matter if you have to run the effluent on the land, because it makes the system doubly sure in its work. I hope to be starting my works presently, and as soon as they are in a condition to make it worth while for the Members to visit West Bromwich, and see the system in operation and dealing with sewage mixed with manufacturers' refuse, I shall be very pleased to arrange for a visit.

Mr. J. **Lemon**: I have much pleasure in seconding the vote of thanks; but I should have much preferred that Mr. Cameron had been present, so that we might have discussed it more fully. This paper gives you only a brief outline of what is being done at Exeter, and I do not think any one can understand the working of the process unless he has seen the works in operation. I have been to Exeter, with the Medical Officer of Health of my town, and by the kindness of Mr. Cameron we took samples of the effluent from the septic tank and from the filter; and the result of the analysis showed that there was very little improvement from the septic tank, in fact the sewage was rather worse than before, but there was a very decided improvement from the filters. On page 290 there is a statement that "domestic sewage can be rendered perfectly innocuous and as clear as spring water without the necessity for using a grain of chemicals." Well, we all agree with that; I think we knew that years ago. I put in a filter in 1878 for dealing with domestic sewage, and after the sewage had passed through that filter it was put on to about six acres of land. That six acres of land was leased by the Corporation to a man at so much an acre. He wrote a letter to the Council complaining that he had contracted for sewage to be delivered on the land, and I was sending nothing but pure water. The result of that letter was that the Corporation abandoned the filter and put the crude sewage on the land. There was no difficulty whatever with domestic sewage, under proper treatment, of producing a clear effluent by ordinary filtration. When you come to the second statement, "that some of the foulest trade sewages in the country are equally amenable to this treatment," I dispute that altogether. It is all very well to deal with domestic sewage, but if you have to deal with some of the trade refuses which our friends in the Midlands encounter, it is a very different matter altogether. Trade refuse means the use of chemicals, and the right sort of chemicals. I am very pleased to hear that one town has appointed a chemist to be constantly on the works to deal with the varying qualities of the sewage as it comes down to the works. I hope to see the day when there will be a chemist permanently employed at every large sewage works which has to deal with difficult trade refuse. I am certain that the appointment of a well-trained chemist would mean the saving of his salary in a very short period of time. I intend to recommend my Board to take that course when our works are more fully in operation. Then, again, there is the statement about the saving of capital expenditure. I am not quite convinced about that. It appears to me it is a question of area. If you work out what is supposed to be done by this system you will find they cannot do with less than an acre of filter for one million gallons of sewage. Well, in a large town that is a pretty big order, and demands a considerable expenditure of money. Then, again, if you have to pay

Mr. Cameron or the syndicate whom he represents a royalty of about 30 per cent. it still further increases the expenditure. The opinion I formed of Exeter was this: that to a certain extent it was a very small experiment, a toy arrangement, from which no definite results could be obtained. The septic tank is really our old friend the cesspool in another form. As regards the filters, I thought they were beautifully designed, but I did not agree with the way in which they were working; because a filter of this kind requires more rest if you are to get a good effluent. There is another point, too, to which I wish to draw the attention of the meeting. Mr. Cameron says: "Not the least of the advantages of the bacterial system is practically the removal of the sludge difficulty and the attendant expense. After one year and ten months' working at Exeter, and dealing with a flow averaging 54,000 gallons per day, the tank shows no sign of requiring the removal of deposit, and the Author is watching with interest how long it will be before any of it has to be removed, as he proposes to work it to its utmost limit." Some of us have seen cesspools which have been in use for many years. I drained the oldest city in England—Winchester—and I found cesspools which had been in use for centuries which had never been emptied, showing that cesspools under those conditions will go on for very long periods of time. I explain that in this way: when decomposition comes on in these cesspools, the excreta is broken up into minute particles, and they pass away in the effluent. Mr. Cameron seems to have answered the question, for he says (page 290): "For one year and eight months of working there was no provision for arresting the minute particles of the deposit coming away in the tank effluent, and which were deposited on the filter surfaces. There is now provided, at the end of the tank, a channel for the deposit of these particles, and, although not sufficiently long under observation, there is an apparent reduction." If the minute particles pass away in the effluent, as I have no doubt they will, this septic tank will go on for a long time and not require emptying. Then as regards the production of marsh gas! Is it a desirable thing that a sanitary engineer should manufacture marsh gas? I am afraid the days of electric lighting are going into the dim and distant future if the Councils are going to light their towns with marsh gas. The Author says he has put up ten lights. Well, if he can put up ten lights from these small works, there is no reason why he should not light the city of Exeter with marsh gas when he deals with the whole of the sewage. I had some discussion about it at the works there, and one gentleman was unkind enough to call it the Exeter gasholder. I will not call it that, but I was not impressed with this manufacture of gas. It will be in the recollection of my friends here that one engineer went there and met with a serious accident. It all comes back to this, *that unless you put the sewage on the land it is a question of area for your filters.* If you could have a very large area of filters you would not want the chemicals you do now. What we do as engineers in the precipitation process is this. We want to deal with the sewage in a small cubic capacity in a very short space of time, and in order to do that we use chemicals to accelerate deposit. If you have time enough sewage will deposit itself. What you do is to use chemicals to increase the rate at which it will deposit itself. That naturally shows it is the question of the area of the tank or the area of the filter. Well, I don't think the consent, or rather the qualified consent, given by the Local Government Board proves anything. There are 20 acres of very suitable land at Exeter, and after the sewage has passed through the filters and the septic tank, it has then to be distributed over these 20 acres of land. It appeared to me, after looking at the surroundings, that the same result could be obtained by the land without the septic tank at all. Then my friend Mr. Greatorex—and he will permit me to call him my friend, for he commenced his professional career at Southampton—is getting a little bit enthusiastic about it, because he saw what has been done at Sutton. I hope he will be successful with the sewage he has to deal with at West Bromwich. But after working these tanks he is obliged to use land to supplement what is imperfectly done (Mr. GREATOREX: No, no). I say you cannot get a sufficiently good effluent unless you have a sufficient area of land to do without the septic tank at all. I look upon the system with doubt. I have spent much time in travelling about the country and investigating these different sewage schemes from time to time. There have been hundreds of patents taken out for dealing with the sewage problem, and they all claimed to have settled the question. We all remember the A B C system. What I complain of is this, that the moment we get a scheme prepared and suitable for the locality—because you must suit your scheme to the local conditions—down comes one of these sewage disposal inventors, and he sees all the members of the Council and says, "there is a good deal in this, but I do not think you had better do what you are going to do," and unsettles their minds as to the utility of the scheme they have adopted. The practical effect—and I speak with an experience of thirty years—the practical effect of many of these inventions has been to retard the proper disposal of sewage. I do not think there is any doubt about that. I hold that we must look upon this scheme with a certain amount of suspicion, especially when we know it is a case of making money for the inventors. I should like to go as far as this, and make it illegal for a man to take out a patent for anything affecting the public health, and then you would soon settle these fads. I have been asked over and over again to be connected with these things, and have always refused, because I think what is done should be done without any self-interest whatever. This scheme requires a good deal of consideration before we are going to say it will be suitable for all parts of England and under all circumstances.

Mr. MacBrair: I am rather sorry the paper does not go into figures and give us the exact cost of the septic tank system, and also that it deals exclusively with this tank system, instead of the wider subject of the title, viz. the bacterial treatment of sewage. The paper almost appears to ignore the fact that sewage can be treated bacterially without the employment of the septic tank. Some months ago I laid down two bacterial filters, some 70 to 80 feet square, and they have now been working for a period of four or five months. One point seriously impressed itself upon me, viz. that the first part of the effluent at the emptying of a first (or roughing) tank or filter is always bad, being much discoloured and very foul. I have a theory of my own to explain this fact. At the bottom of every filter it is the custom to put in two or three inch pipes for under drainage. The first portion of the sewage gets into these pipes and never gets any treatment at all. When you empty the roughing tank, this foul sewage is naturally the first to flow into the next tank, where it again goes to the bottom. Consequently you have a quantity of sewage which never continues in contact with the coke. It seems to me that the only way to prevent this state of things happening is by not under-draining your filters, or, at least, only under-draining the 3 or 4 feet radiating from the valve, so that the whole of the sewage which goes down must continue in contact with the coke before it flows away. We are told that it is easy to get refuse material for a filtering medium. When I was at Oswestry I saw a large heap of refuse (domestic ashes), which had stood for years and from which all the organic matter had departed, and which of course would form a suitable filtering medium. But in Lincoln we have not such a heap of ashes as that ready to hand. I wanted some 20,000 or 30,000 loads to deal with our sewage, and having no other filtering material, I had to turn to our gas manager and try coke at a cost of from 7s. to 10s. per ton. I have been to Sutton and seen the beautiful effluent obtained there, but with the sewage I have to deal with I have not been able to equal it. The best result we can obtain so far is 1·4 grain oxygen absorbed in four hours, but Mr. Chambers Smith tells me he gets it very much under 1 grain. I have not been able to get it down to that figure—I wish I could. We are told that these filters should have absolute rest on one day in the week, and I think you will agree that the rest day should be Sunday. But in that case where is your Sunday sewage to go to, and what are you going to do with the Sunday flow? That means you must have additional filters to those required for the ordinary flow of the sewage. Mr. Greatorex tells us that the Local Government Board have granted a loan for West Bromwich for seven years, but that if it proves a success in three or four years' time they will grant an extension for the repayment of the loan to the ordinary period granted for sewage works. I should like to ask him a simple mathematical question. In three or four years they will accordingly have repaid half their loan, and if they are then to spread the remainder over twenty-three years, is it so great a benefit after all?

Mr. J. S. Pickering: I think it is a step in the right direction that the Local Government Board have sanctioned the loan, though conditionally, for the West Bromwich works. I do not think it is quite clearly understood that the West Bromwich loan is for a large experiment, so that the number of years for which it is granted is not a great matter. If it is a success the Corporation will adopt the system, and then the Local Government Board will give the full term for the repayment of the loan. I can bear out what Mr. Cameron says as to foul trade sewages being amenable to the biological treatment. Notwithstanding that Mr. Lemon is sceptical—and I admit that I was sceptical six months ago—there is evidence that trade sewages can be treated in this way. I have one of the foulest trade sewages in the country to deal with, and some four or five months ago I laid down a filter of 100 square yards, composed of coke breeze, and every day since I have been pouring sewage in its crude state on this filter, without the use of any chemicals. The results have been satisfactory, and undoubtedly the effluents are now better than they were at the commencement of the trial. That is proof that manufacturers' refuse liquors are to some degree amenable to this bacterial treatment. Indeed, I am so satisfied with the result that I am going to try it on a larger scale. I should like to say that we have a number of artificial filters composed of coke dust. I do not know that this material is used in other towns, but I scarcely think it is necessary to go to the trouble and expense of getting coke breeze of different sizes, as usually recommended for the secondary filters, if the treatment can be equally well carried out with coke dust, a material which we are able to buy for 1*s.* per ton, as compared with 7*s.* to 10*s.* charged for coke breeze. I have had the beds working for three years, and they are in as clean a condition as when put in. Mr. MacBrair referred to the under-drainage of the filters. It has always struck me as being a weak point in these filters, as you have a certain amount of under-drainage where no purification can take place. I have come to the conclusion that if you put coarse material at the bottom it is not necessary to under-drain the filter with drain pipes. I recently examined a filter under-drained with 4-inch land pipes laid on the floor of the filter. The invert of the pipes being slightly above the floor, it was found that the layer of material below the invert was contaminated with decomposed sewage, but above was quite clean, showing that the under-drainage in this case was objectionable. I am sorry Mr. Cameron is not here to enlarge upon his paper, as I know he is very enthusiastic about his treatment at Exeter. It is interesting to know that the system at West Bromwich is not patented in any way, and that we can try experiments for ourselves at very little cost.

Colonel JONES, V.C.: Like the previous speakers, I regret Mr. Cameron's absence, because I am very much disappointed with the paper which he has put before us. There is some truth in it, but that is all old, and what is not old is not true. That is my general opinion of what is put forward here. We all know that domestic sewage can be treated by filtration; we have always known it. And in the case of cesspools we have always known that they produce the results which are put forward, i.e. the production of marsh gas. We have been accustomed, however, to consider that gas as very offensive, and the object of taking sewage away from our towns is that the marsh and other gas should not get into the houses. One point I should like to say something about is the automatic process at Exeter, upon which alone it is patented. I believe that Mr. Wynne-Roberts, C.E., of Oswestry, has a very similar plan for automatic transfer of the effluent from one filter bed to another. The thing I complain of is that it is not justifiable to say there is a great saving in this automatic arrangement before it has been tested in practice on a large scale. I prefer good intelligent hand labour in anything that has to do with the treatment of sewage. Sewage has a way of clogging and choking up which upsets all kinds of mechanical arrangements, and necessitates very careful supervision. I think that the automatic gear will be found in time to be unsatisfactory, and at any rate it will not save much. As to the emptying of these tanks, Mr. Lemon very truly says, we all know cesspools which do not require emptying, because they have overflows or are made in chalk or some porous material through which the particles get away unobserved. I have been waiting all along for the Exeter tank to be emptied. It was a matter of regret that the inspectors of the Local Government Board on the recent inquiry at Exeter, did not say, "kindly empty that tank, and let us see it in the morning." They were content with the evidence given, as at the Sanitary Congress at Leeds, that the tank after a year's use was a quarter full of sludge. The amount of "humus-like matter" was said by Mr. Cameron to be so many inches thick on invert of the tank, and the floating scum amounted to so many more inches. I put the two together and made it about 2 feet, consequently, as the depth of the tank was 8 feet, it must have been a quarter full of sludge. I say we want to know how much there is now, and when it is to be emptied. If the tank was calculated to dispose of one day's sewage, was built to hold that amount, and it was a necessary part of the process that it should hold a day's sewage when it was a quarter full of sludge, there was only space for three-quarters of a day's sewage. My explanation of the reason that the tank is not full now is that it is subject to flushes. The storm water to some extent passes into this tank, and if it is calculated only to take the dry-weather sewage, and there falls half an inch of rain in twenty-four hours, the whole of its contents will be stirred up and swept out. I am sorry Mr. Cameron is not here, as I do not like to find fault with the paper in his absence. I am very sorry that we cannot get public opinion sufficiently interested in any matter affecting sewage. We want our rivers purified, and we want the public to watch the results as practical men. Instead of that, they say, "it is nothing to us, we leave it to the chemists and the engineers." The public ought to take more pains, for the result of their apathy is that they become the victims of speculative syndicates and money-making people. In 1887 I was present at the Annual Meeting of this Association, when Mr. Webster brought forward the electrical system of sewage treatment. I was never more astonished than to find even a body of Borough Engineers, whose attention had been given to sewage for years, getting up and receiving this as a message from heaven and a solution of the whole thing. There is just now a kind of feeling going about that these systems under new names, "Bacteriological," are something new; whereas bacteria have been working upon our sewage for thousands of years. There is nothing new in it, for Mr. Dibdin has long discarded his first idea that the microbes had to be bred and increased in number—quite an unnecessary novelty. The only working conditions which the advocates of these "new" systems put forward, are those conditions which the late Mr. J. Bailey Denton and everybody insisted upon long ago, viz. that you are to provide the most porous possible material for the filtering medium, and that the sewage should pass through it at a reasonable rate *intermittently*. The whole thing depends upon intermittent or alternate presence in the pores of the filter of sewage and air.

Mr. A. H. Campbell: I regret exceedingly that in the absence of Mr. Cameron aspersions and suggestions of this kind should have been brought forward in connection with this paper. It may be correct, it may not be, but I hope that I have a more innocent mind than to suggest it, in connection with the scientific side of this paper. I have been to Exeter; I went there with an unprejudiced mind, as a learner and not as one who from thirty years' experience had learned to trust to land as the be-all and end-all of sewage purification. There are, no doubt, conditions in which Mr. Lemon's experience of land has fulfilled all that is desired. Land is all right when you can get it of suitable quality sufficiently removed and isolated, but every one of us has to meet the conditions of the cities and towns where we work, and even admitting land is what Mr. Lemon has claimed it to be—

Mr. **Lemon** (interposing): I did not say a word against filtration. I am an advocate of filtration.

Mr. **Campbell**: Colonel Jones said so, however. My point is this: that the Local Government Board, in their recent sanction of the Exeter loan, have made a remarkable concession as to the amount of land required, in allowing one acre to every 2000 persons. I came back to Canterbury, and constructed a tank similar to what Mr. Cameron has at Exeter, and it has now been at work four months. I did not come fortified with our analyses, because I did not think that these would be required, but I may say that it has worked satisfactorily. If the Exeter tank, and the Canterbury tank on the Exeter lines, produce such a wonderfully clarified effluent from a very bad sewage, and enable us to so greatly reduce the area of the land, whilst helping the land to do its work, then I say that Mr. Cameron has accomplished much. There may be nothing new under the sun, but there are developments of old practices, there is the reducing to a science, as Mr. Cameron and Mr. Dibdin are now doing, of what on the land is an unknown, uncertain and indefinite purification of sewage. By these tanks we are able to define it and reduce it to the exact principles of a science.

Mr. **Smith-Saville**: My Authority carried out a precipitation and filtration scheme, but never erected sludge presses. As a consequence, the sludge is accumulating, and has given us much trouble. After hearing what was being done at Exeter and other places we are loth to incur this expense, lest in a short time sludge presses might be found unnecessary. My Committee therefore instructed me to carry out an experiment on the biological system. I covered in a tank already constructed, with filters which have now been at work for some time, but we have never produced any marsh gas, though the sewage manager thought he was going to light the works with it. Though the system has been going three months, there is not very much sludge in the tanks; certainly it has reduced the quantity of our sludge to one-fourth. We produce 53 tons of sludge per million gallons of sewage, but in the experiment it is only 8 tons, with no chemicals used in either case. I regret to say, however, that the effluent from the tank has never been so good as to justify me in having it analysed. It is of a milky colour and there are numerous slight particles in it. I allow a fifteen hours' flow through the tank to enable it to clarify, and we then pass it through two filters alternately. The filter takes an hour to fill, rests two hours, is then run off and aerates for two hours. The effluent from the filters is not very good, not so good as with the ordinary coke and sand filters. I had anticipated that the first lot of sewage would scarcely get treated at all, therefore I filled the bottom portion of the tank with 9 inches of coke dust so as to purify it better, and so not to leave a large space at the bottom for the first flow to lodge in. The filters were used at first at the rate of 208 gallons per square yard per day (proportionate to 1,000,000 gallons per acre), but we had afterwards to reduce this considerably, and I feel convinced that not more than half this quantity can safely be dealt with per day. We do not get an effluent such as I should feel justified in sending into the river, or that the Rivers Board would accept. The tanks and filters used were originally designed for the International process. We were told it would require very little water to clean these filters, but to keep them in proper order each has to be washed daily, and the result was that they were found to be much too small. I have laid out some land we possessed, and I had a theory that sewage land draining had never been carried out from a biological point of view, and that therefore as the upper soil principally carried out the purification it was not necessary to put down drains 6 feet deep, and therefore I put in the land drains 3 feet 6 inches deep, and about 12 feet 6 inches apart, each end being carefully ventilated, so as to allow for thorough aeration. Owing to the proximity of a heap of engine ashes, and the land being rather close, I mixed a small proportion of these with the soil, and we have been passing the dirty washing from the filter surfaces, which is very foul and greasy, to the extent of 60,000 or 70,000 gallons per acre per day consecutively through this land. This, I feel sure, is far in excess of the quantity usually passed through land, and we have obtained in this way a beautifully clear effluent, and have had no trouble whatever; and considering that the Local Government Board insist upon land, it is, in my opinion, well worth consideration as to whether land should not receive more attention for its better drainage and aeration than it has done. The septic tank is a system which requires to be very carefully watched and looked on with much caution. Whatever may be the case at Exeter, it does not appear suitable for the treatment of a strong sewage like ours, from the experience gained from our experiment.

Mr. C. F. Wike: I have not had an opportunity of visiting the tanks at Exeter which have been referred to, but I have seen those at Sutton. At that time the position of manager at the Sheffield Works was vacant, and as the Corporation were desirous of experimenting with the bacterial system I advised the committee to appoint the manager from Sutton. Our works have been established about twelve years, and consist of 30 tanks, each with a capacity of 50,000 gallons. Any tank can be worked separately from the others. The system is lime precipitation, and the effluent is passed through coke filters. Almost 1000 tons of wet sludge is produced per week. For the purpose of experiment I allocated three of these tanks. One was piled with small coal (slack), and the other two with coke. The sewage passing through the slack tank and one of the coke tanks was interrupted before it reached the liming machines, and passed through in its crude state except that there was a settling tank to take out the rough material and detritus. The other coke tank was supplied with sewage limed in the usual way. These experiments were commenced at the end of December last, and for some time we did not get any good result. I may here say our sewage is not the most suitable for the bacterial system, because at times it receives a considerable quantity of trade refuse, acids, vitriols, &c., which have the effect of sterilising the filters. For several weeks I was afraid the experiments were a failure, but I am pleased to say that now we get from one of the filters a very satisfactory effluent. The slack filter, although fairly satisfactory, was not found to give such good results, and was therefore abandoned. This also applies to the coke filter through which the limed sewage passed. We are cramped for tank room, and it was considered advisable to utilise in another way those filters which were not so successful. The remaining filter has now been working about seven months, and as yet no sludge has been taken out of it. It is perfectly sweet, and when the coke is turned over there is only a smell of mould. The effluent is passed through coke breeze, and analysis shows it to be very satisfactory. I am not in a position to give the figures to the Association now, but hope to be able to do so at some future time. The Sheffield works were designed for the treatment of 10,000,000 gallons per day, but now, through the admission of surface and spring water, &c., to the sewers and the trade refuse, we often get as much as 20,000,000 gallons per day passing through the works.

The PRESIDENT: I think it is very gratifying to the Association that we should have some record of this interesting system of sewage treatment, and I am glad it has provoked so interesting a discussion. Without wishing to enter into the debate, I may say there is one very important point we ought to get from Mr. Cameron, although it affects our Councils more than any one else, and that is the cost. I do not wish to associate Mr. Cameron with *l. s. d.*, but in reporting to our Councils we ought to know what the cost of adopting the septic tank system really does mean, over and above the actual construction of the works. I do not myself perfectly understand what this 30 per cent. royalty commission refers to. I have understood it means 30 per cent. upon the whole of the constructive works, including tanks and filters. I can hardly credit that, because I presume it is not possible to patent an ordinary settling tank. The ironwork attached to it may be patented, but surely the ordinary settling tank cannot be patented any more than the microbes themselves. It would be very useful if Mr. Cameron gave us that information, which is absolutely necessary in reporting to our Councils on the matter.

The vote of thanks to Mr. Cameron was then accorded unanimously.

A TWO HOURS' TEST OF A STEAM RAM PUMPING PLANT.

By J. B. Wilson, Assoc. M. Inst. C.E., Cockermouth.

The Author has repeatedly met, during his professional practice, with both manufacturers and users of steam rams, whose views on the economical principles which govern the design and proportion of these important adjuncts to public water supply appeared to him to be at variance with well-known laws of hydraulics.

In order, therefore, to try and elucidate the difficulties involved, he has taken the liberty of bringing this subject before the Association, with a hope that discussion thereon may lead to more improved methods of construction in the future, in country districts, where the experienced engineer is not always available.

The two chief failings to which he would draw attention are (1) the adoption of a large-sized ram to a comparatively small-sized main and suction pipe, (2) the laying of undulating rising mains without air valves or ventilation of any kind.

Taking these questions in the order given, (1) the reason assigned for this procedure is, "*There is nothing like having plenty of size and weight.*" If weight is needed, why not increase the size of steam cylinder, that being the source from whence the power is derived, and not from the ram? but if size is wanted, what may be termed the "double" capacity of the ram should be obtained by extending its length and not by increasing its diameter, as by so doing, if the capacity is doubled, the load of resistance is also doubled, which is not the case if it is extended, as the sectional area remains the same.

The following tables give the results of a two hours' test of a vertical pumping engine with two single-acting rams. Table I. gives the load at 17 revolutions per minute, which is equal to a velocity of 1·41 feet per second in the main. Table II. gives the load at 28 revolutions per minute, equal to a velocity of 2·33 feet per second. This test could only be tried for about five minutes, as the 9-inch suction pipe could not keep the two 12-inch rams supplied with water, and the impact was so great that the speed had to be reduced to 17 revolutions, which was found to be the maximum speed that the engine could be run with safety.

The proportions of the engine are as follows:—Steam cylinder, 12 inches diameter, 15-inch stroke; ram, 12 inches diameter, 15-inch stroke; suction pipe, 9 inches diameter, 12-feet lift from bottom of tank; rising main, very undulating, no air valves, one mile in length, 8 inches diameter, 155 feet rise to reservoir.

The suggested proportions of engine, given by way of comparison, are as follows:—Cylinder and rams, 2 feet 6 inches stroke, 8 inches diameter; suction pipe and rising main, 8 inches diameter; all other particulars same as in the first case.

Delivery, Table I., 180 gallons: Table II., 300 gallons per minute.

TABLE I.

Particulars and Items of Load.	12-inch Rams.	8-inch Rams.
	lbs.	lbs.
Weight of column of water to be lifted = $62 \cdot 4 \times n D^2 H = W$	7596·38	3253·78
Friction on piston = $W \times \cdot 06$	455·78	200·22
Friction of the water in the rising main, excluding rams = $\frac{G^2 \times L}{(3\,d)^5} = H$	71·30	71·30
Resistance due to contraction and friction in suction pipe = $\left(\frac{d^2 \times 13}{G}\right)^2 = H$	4·34	7·15
Resistance due to valve, say	4·00	4·00
Total load of resistance	8131·80	3536·45
Which = per square inch of sectional area of ram	71·12	71·27

The actual pressures registered by the gauge on the rising main were, at rest, 64 lbs.; working, 78 lbs., per square inch.

x 2

Note.— $n = \cdot 7854$; D = diam. of main in feet; H = head in feet.
d = diam. of main in inches; W = weight in lbs.
G = number of gallons per minute.
L = length of pipe in feet.

TABLE II.

Particulars and Items of Load.	12-inch Rams.	8-inch Rams.
	lbs.	lbs.
Weight of column of water to be lifted	7596·38	3253·78
Friction on piston	455·78	202·22
Friction of the water in the rising main excluding rams	195·93	195·93
Resistance due to contraction and friction in suction pipe	12·15	14·06
Resistance due to valve, say	4·00	4·00
Total load of resistance	8264·24	3667·99
Which = per square inch of sectional area of rams	73·13	73·36

The actual pressure registered by the gauge on the rising main was 100 lbs. per square inch = to a load of 11,300 lbs. on the 12-inch rams. The 26 lbs. excess pressure recorded, the writer considers is caused by "air-lock" in the rising main, from want of proper air valves on the summits of the several undulations.

This air-lock is still further amplified by a continuous series of blown joints, which take place usually on the up side of the summits, rarely more than a few feet down on the rise side, and never in the bottoms of the hollows. On summing up the foregoing facts, the Author is of opinion that they prove beyond doubt that no ram should exceed in diameter the suction and rising main to which it is connected, otherwise an economical loss takes place, which in the case before us amounts to 125 per cent., or, inclusive of "air-lock," 208 per cent., of waste over and above the necessary requirements to raise the water specified.

(2) As to the ventilation of rising mains on undulating ground. No main should be laid, in such case, without suitable air valves, as air-lock ensues, causing an unnecessary excess of pressure in the mains and reducing the flow. The reason given for this arrangement was, "*The main works solid, and therefore must be right;*" but the solidity is not always experienced, or there would be no blown joints.

The air valve recommended is a small air receiver cast on the top of the main, of the full diameter of the main, on the summit of which a small brass air valve (ball valve) is fixed, similar to the valves used on hot water cylinders; through this valve the air is forced out under a slight pressure, which steadies the upward flow of the water and prevents waste. The Author has used these valves in barns, filled with hay, with success; they were fitted on pressure tanks.

DISCUSSION.

Mr. A. E. Collins: I should like to propose a vote of thanks to Mr. Wilson for this interesting record of tests. These records of tests are as interesting as anything we can have, because they are records of actual facts. I do not quite agree with all the deductions Mr. Wilson draws from his tests. I agree with Mr. Wilson as to increasing the area of suction and delivery pipes to that of plunger, for a pump running at high speed. I was articled to a firm of engineers who, eighty years since, made their suction and delivery pipes the same diameter as the plunger; but there seems to be a rule of thumb with some of the smaller manufacturers, to make these pipes only half the diameter. If you are running at high speed you must have plenty of space in the suction pipe. I scarcely know how Mr. Wilson arrives at the amount of friction on the 12-inch and 8-inch rams respectively. It is all a question of the manner in which the plungers or rams are packed. With equal packings the friction should increase in proportion to the diameter, and you should have one-third more friction on a 12-inch plunger than on an 8-inch plunger, instead of a difference as between 455·78 lbs. and 202·22 lbs. I take it that it would be two-thirds of 455 lbs. in the second case, or about 300 lbs. If you are going to reduce the size of the plunger, and get the displacement by increasing the speed, you will increase the loss due to friction by the increased travel of plunger or ram, and consequently get more friction in proportion with the smaller plunger than with the larger one. If the rising main is air locked you will not get a proper delivery. I had a case of that description in which I thought I had provided plenty of ventilation, but I had not, and as a result I could only deliver at the rate of 1000 gallons in five minutes; but by increasing the ventilation I raised the quantity delivered to 5000 gallons a minute. I do not understand what Mr. Wilson means by the air valve discharging in a barn.

The PRESIDENT: I have much pleasure in seconding the vote of thanks proposed by Mr. Collins to Mr. Wilson for this very interesting and useful paper. It certainly will, as Mr. Collins says, serve as a very valuable means of reference in our Transactions.

The vote of thanks was unanimously accorded, and formally acknowledged by Mr. Wilson.

THE ELECTRIC LIGHTING OF EDINBURGH.

BY FRANK A. NEWINGTON,
RESIDENT ELECTRICAL ENGINEER.

THE Corporation of Edinburgh obtained, in 1891, a Provisional Order from the Board of Trade for the Electric Lighting of the City. The building of the station and the work of laying the mains in the streets was commenced in May 1894, and the supply of electric energy was first commenced on April 11th, 1895.

Professor Kennedy is the consulting engineer to the Corporation.

GENERATING STATION.

The building is situated in Dewar Place and Torphichen Street. It consists of the boiler house and engine room on the ground floor, the coal store over the boiler house, and the battery room, meter-testing room and store over the engine room. The offices being at the south corner of the building.

BOILER HOUSE.

The boiler house is 152 feet long by 46 feet wide. This at present contains 13 boilers; 4 others will be erected within the next three months.

The boilers are of the dryback type, 10 feet 3 inches diameter by 12 feet long, with two Purves flues 3 feet 3 inches diameter, and 166 tubes of 2¾ inches internal diameter. They are designed to evaporate 10,000 lbs. of water per hour, the working pressure being 160 lbs. per square inch.

The boilers are fitted with mechanical stokers of the coking type. Directly above the shells of the boilers, superheaters are fixed, each of these consisting of two nests of zigzag tubes or coils 1½ inch diameter; there are 26 of these coils to each superheater. The coils are connected at both the back and front of the boiler to a cast-iron pipe; the steam from the boiler enters at the back pipe, then passes through the coils and leaves by the front pipe.

The gases, after leaving the furnace flues, enter a brick combustion chamber, pass through the tubes to the front of the boiler, over the top of the boiler around the superheater tubes, and then down each side of the boiler to the main flue. By these means the steam is superheated 40° to 60° Fahr.

Feed Pumps.

There are two duplex steam pumps, having a maximum capacity of about 6000 gallons per hour each, and three 3-throw pumps driven through gearing by electric motors, each with a capacity of 4500 gallons per hour.

There are two ranges of feed-water pipes, and each boiler is fitted with two check valves. The feed water is measured by Kennedy water meters, and is heated by exhaust steam feed heaters. There are three electric motors in the pump room, for driving the shafting for the mechanical stokers.

The coal is delivered in railway trucks by a siding from the Caledonian Railway. At the east entrance to the boiler house there is a hoist driven by an electric motor, which lifts the truck to the coal store level; railway lines are fixed the whole length of the coal store, 8 feet 6 inches above the floor level, and the trucks are drawn along these by means of an endless rope also driven by an electric motor. The coal is unloaded on to the coal store floor, and runs into hoppers fixed to the ceiling of the boiler house, there being one hopper to each pair of boilers. Immediately below the hopper there is a measuring box, holding 4 cwt. of coal, having slides at the top and bottom; below this box are the shoots for leading the coal into the hoppers of the mechanical stokers. The slides in the measuring box are arranged so that on opening the top one the measuring box is filled with coal; this is then shut and the bottom one opened, a measured quantity of coal being delivered to the boiler each time; ordinary counters are connected to the slides to indicate the number of times the slides are opened. This arrangement works admirably, saving a large amount of labour.

ENGINE ROOM.

The engine room consists of a building 102 feet long by 98 feet wide, divided down the centre by a row of columns: these carry the roof, which is in two spans.

The machinery at present erected consists of—

Two 100-I.H.P.	engines	coupled to	two 60-K.W.	dynamos.
Two 250-I.H.P.	„	„	two 155-K.W.	„
Ten 360-I.H.P.	„	„	ten 225-K.W.	„
Two 150-I.H.P.	„	„	two 84-K.W.	alternators.
Two 240-I.H.P.	„	„	two 150-K.W.	„

The engines are Willans' central valve type, running from 350 to 450 revolutions per minute, and are direct coupled to the dynamos and alternators.

Both high- and low-tension systems of distribution are in use, the high-tension mains supplying the outlying parts of the city, and the low-tension mains the more central part.

The dynamos are two-pole shunt-wound machines, the 10 large machines are wound for a pressure of 460 volts, the four smaller machines for 230 volts.

The four alternators are designed for 2100 volts.

The engines and dynamos are bolted down to a solid block of concrete about 7 feet thick. This is not in contact with the walls of the building, there being a space of about 3 feet between them. The steam pipes form complete rings both in the boiler house and engine room, and the stop valves are so arranged that any section can be shut off without stopping more than one engine or boiler.

The main steam pipes are 8 inches in diameter, the straight lengths being of steel, with the flanges screwed and brazed on, the bends of copper with steel flanges. The pipes are carried by rods from brackets fixed to the walls, thus allowing for expansion. The branch pipes to the engines are of copper.

Four direct-coupled sets of 390 K.W. capacity, two for the low-tension system and two for the high, will be erected in about three months' time. This new plant will fill up the station. The engines for these sets will be of the Belliss high-speed type.

SWITCHBOARDS.

The switchboards are arranged on a raised platform at the west end of the engine room.

LOW-TENSION SWITCHBOARD.

This is arranged for 18 dynamos and 19 feeders. The current from the dynamos is carried by cables laid in trenches under the engine room floor to the switchboard, passing through fuses, automatic switches and ampère gauges to a common bar, to which the feeders are also connected.

The feeders on leaving the switchboard are carried into a cellar below, and then run to various parts of the city. On starting an engine, it is run up to its proper speed, which is regulated by the governor, the stop valve is opened out full, and all the regulation is done by the switchboard attendant, by means of a resistance in the shunt winding of the dynamo.

HIGH-TENSION SWITCHBOARD.

This is arranged for 7 alternators and 7 circuits. Each alternator and circuit has a fuse and ammeter and two single-pole switches. There are two omnibus bars, either of which can be connected to the inner conductor of the concentric mains by means of the circuit switches. The outer conductor is permanently connected to the machines, and is also connected to an earth plate in the station.

There are seven Ferranti rectifiers for changing alternating currents to rectified currents for arc lamps, with the necessary switchboard for six circuits of arc lamps. Each rectifier is capable of lighting 35 to 40 12-ampère arc lamps in series. The rectified circuits are used to supply the outlying street lamps.

BATTERY ROOM.

There are two batteries, one for the positive, the other for the negative side of the system; each consists of 128 cells, having a capacity of 850 ampère hours, at a discharge rate of 180 ampères.

The batteries are always connected to the omnibus bars on the switchboard, but as the pressure of the dynamos is not sufficient to charge all the cells at once, motor generators or boosters are used; these are put in series with the dynamos, and are capable of increasing the pressure of the battery circuit 100 volts or so above the pressure of the dynamos. By this means the batteries are very conveniently worked, it being possible to charge them at any time. The cells are of the Crompton-Howell and Tudor types.

DISTRIBUTION. LOW-TENSION SYSTEM.

The system used is a three-wire network, with feeders at various points supplying it direct from the generation station.

FEEDERS.

There are at present 16 pairs of conductors going out of the station. The points at which these feed into the distributing network are arranged according to the demand for energy in different parts of the city, the section of the conductors also varies for the same reason. From these feeding points pilot wires are brought back to the station and connected to voltmeters, which show the pressure of the supply at these points.

The feeders chiefly consist of bare copper strip, carried on insulators in concrete culverts; where it has not been possible to use this on account of there not being sufficient room between the pavements and the cellars of the houses, Siemens armoured cable has been laid down. One of the chief advantages of using culvert and copper strip lies in the ease with which the section of the conductor of any feeder can be increased, as the load on that feeder increases. All that it is necessary to do is to add one or more extra strips of copper. The usual section of the copper strip is 1 inch wide by ¼ inch thick, and any number of these up to about six (or 1½ square inch section) can be used.

DISTRIBUTING MAINS.

The distributing mains in use are insulated with india-rubber, bitumen or paper. They are drawn into Doulton stoneware casing when laid under the pavement, or into cast iron pipes under the roadway. The pressure between the two outer mains is 460 volts, or between either outer main and the middle wire 230 volts: that is, the pressure at the consumers' lamps is 230 volts. The distributing network of one district is connected to that of another district as much as possible, in order to ensure an even pressure throughout the system.

HIGH-TENSION SYSTEM.

This is used for the outlying and scattered parts of the city.

The conductors in all cases are concentric cables, insulated with paper impregnated with oil, and lead-sheathed. These are laid in Doulton stoneware casing or in iron pipes.

Armoured cable laid directly in the ground is also in use.

The pressure of the high-tension mains is 2100 volts, this is reduced to either 230 or 115 volts before entering the consumers' premises. The transformers for this purpose are contained in cast-iron water-tight boxes which are sunk under the pathway. The size of the transformers varies according to the number of consumers supplied by them. An extension of the high-tension mains is now being made to Portobello, about 5 miles distant from the generating station.

Transformer sub-stations with a low-tension distributing network will be used.

PUBLIC LIGHTING.

There are now 608 arc lamps in use in the city, 441 of which are lighted from the low-tension mains, and the remainder by the rectified circuits.

The lamp posts are placed 60 to 70 yards apart, except those in Princes Street and Leith Walk, which are only about 45 yards apart. The lamps hang from a bracket projecting from the top of the posts, the centre of the lamps being 23 feet from the pavement.

The circuits for the arc lamps have been arranged so that alternate lamps are on different circuits; this allows every other lamp to be switched out at midnight. The low-tension lamps are connected to the distributing mains, but the rectified lamps require separate conductors laid from the station for each circuit. These lamps are switched on and off at the station, but in the case of the low-tension lamps the lamp trimmers go round to switch them on and off.

The public arc lighting is now being extended by the addition of 130 lamps.

A site of about 3½ acres has recently been acquired by the Corporation at the N.E. end of the city, on which another generating station will be erected. Only a part of the ground will be built on at present, the buildings being designed for about 10,000 horse-power of machinery. The station when completed, however, will contain machinery of 40,000 to 50,000 horse-power.

FINANCIAL RESULTS.

When the supply was commenced on April 11th, 1895, there were about 20 consumers connected to the mains, having an equivalent of 2500 8-candle-power lamps, and 46 street arc lamps.

At the completion of the first year's working, on May 15th 1896, there were 507 consumers connected, having 53,250 8-candle-power lamps and 245 street arc lamps.

On May 15th, 1897, there were 900 consumers connected, with 91,980 8-candle-power lamps and 471 street arc lamps, and on May 15th, 1898, there were 1630 consumers, with 149,480 8-candle-power lamps and 556 street arc lamps.

During the last twelve months, therefore, an average of more than 1100 8-candle-power lamps have been connected to the mains each week, and applications for a further 15,000 8-candle-power lamps have been received.

The price per Board of Trade unit at first was 6*d.* for lighting, with discounts amounting to 25 per cent. according to the quantity used, and 3½*d.* for power and heating.

This has been reduced each year as follows:—

Year 1895–6, Lighting 6*d.* per unit, Power 3½*d.* per unit.
„ 1896–7, „ 5*d.* „ „ 3*d.* „
„ 1897–8, „ 4*d.* „ „ 2*d.* „
„ 1898–9, „ 3½*d.* „ „ 1½*d.*

The public arc lamps, arc lamp posts, and all cables, connections, &c., are supplied and erected by the Electric Lighting Department, who also trim the lamps and keep them in repair, for which the following charges have been made:—

Year 1895–6	£20 per lamp per annum.
„ 1896–7	£18 „ „
„ 1897–8	£16 „ „
„ 1898–9	£14 „ „

The following are the units sold during each year:—

	1895–6.	1896–7.	1897–8.
Private Lighting ..	556,744	1,052,570	1,973,315
Power	13,914	47,727	86,654
Public Lighting ..	331,043	621,276	834,660
Total	901,701	1,721,573	2,894,629

The capital expended on the undertaking now amounts to about 282,000*l.*

A reserve fund has been commenced, 4050*l.* having been put aside for this purpose for the year ending May 15th, 1897, and 4000*l.* for the year ending May 15th, 1898. A considerable net profit has been made each year, after paying all charges, including interest and sinking fund on the capital expenditure and the contributions to the reserve fund, in spite of the reduction in the price of energy.

Year.	Net Profit.
1895–6	£3,976
1896–7	£3,374
1897–8	£2,000 to £3,000 (estimated, as the figures are not yet completed).

The following table gives the works, cost and total costs per unit sold, for the years 1895–96, and 1896–7. The figures for the year 1897–8 are not quite ready yet. Works costs include fuel, oil, water, stores, wages and maintenance. Total costs include Works Costs, Salaries, Management, Rent, Taxes and Insurance.

	Works Costs.	Total Costs.
Year 1895–6	·92*d.*	1·67*d.*
„ 1896–7	·63*d.*	1·13*d.*

The growth of the undertaking has been extremely rapid, and the results very satisfactory. This, I think, has been largely due to the policy which the Corporation has adopted: namely, of extending the supply mains wherever there has been a demand for electric energy, and in reducing the price per unit as quickly as possible.

DISCUSSION.

Mr. J. Patten Barber: I am not an authority on electric lighting, and therefore I will not attempt to criticise the paper. I feel, however, that I should like to propose a vote of thanks to Mr. Newington for so kindly preparing this paper. We have our own electric light engineer at Islington, and he has entire charge of the works which he designed. I wish we could show the same result as you do at Edinburgh, but I hope before long we shall be able to show a much better result than we do now. I think the policy which Edinburgh is adopting, of laying mains wherever the demand justifies it, and of reducing the price of current whenever they can, has brought about the excellent financial results which have been obtained. I think the paper distinctly shows the advantage of these undertakings being in the hands of the municipality. We are certainly hoping in Islington—which is not a rich parish by any means—that we may be able to show good sound financial results. At the present time we are not losing but making money, and we should probably have more consumers and a much better financial result than at present if we were to make a plunge like a company would do, and reduce the price of current at once to the consumers. The Vestry can scarcely do that, because they are dealing with the money of the ratepayers, and not of shareholders, and they would not like to take a step which might result in a present loss, though it would increase the business and profits in the future. Still, I hope that before long we shall be able to show much better financial results. We have solved this problem, that electric lighting can be done well by the municipality and without losing money. I wish we could show, as at Edinburgh, that it can not only be done economically but at a profit to the ratepayers. I envy this city, and I hope in time we in London shall be able to do what they are doing at Edinburgh. It is most encouraging to come here and learn that the electric lighting is so well and economically done, and I sincerely thank Mr. Newington for his paper.

Mr. J. LEMON: I feel a special interest in this subject, and have very much pleasure in seconding the vote of thanks. I do not know that I ever read a paper which gave so much information in so small a space. I have had some experience of electric lighting. I advocated that we should purchase the license of the then company at Southampton, which we could have obtained for 500*l.*, and the Council in their wisdom would not do so. The company went on and spent 21,000*l.*, and I again pressed that we should purchase the works. We succeeded in purchasing the concern at par, that is to say, we gave the company what they had expended. When I tell you they were then paying a 5 per cent. dividend on their capital, I think you will agree we made a good bargain. This has been the result. We have had the works in hand two years, and we are now extending them, on which we are laying out 60,000*l.* We are able to show a return of 7 per cent. upon the capital we have expended; but of course we are not able to show a return upon capital during construction. We have also made considerable reduction in the price of current to the consumers. The company used to charge 7*d.* per unit, we have reduced it to 6*d.*, with a heavy discount after a certain quantity, and we only charge 3*d.* per unit for power purposes. The results of that reduction have been curious. There has been a great increase in the number of consumers, and a large increase of revenue, which shows we have adopted the right principle. Whenever there has been any desire shown by residents to take the electric light, we have extended the mains in all directions. Mr. Barber has alluded to the difficulties with which a local authority are met in carrying out works of this character. We of course in our Council have reactionaries and obstructionists, as in most other authorities, and only last week they made a fierce attack upon the Electric Lighting Committee because they could not show a return upon capital during construction. That is one of the things you have to meet with in carrying out public works. Then there is that bugbear the Local Government Board. After we had made an excellent purchase we applied to the Local Goverment Board for a loan, and they would not allow us more than fifteen years for the repayment of 21,000*l*. I need not tell you that is a very heavy charge upon the undertaking, and I say too heavy a charge. Notwithstanding that fact, we were able to pay that very large sinking fund and interest upon capital and show a balance at the end of last year. We did this, notwithstanding we reduced the price of the current. I think that is a satisfactory result; but the results we have obtained are nothing to compare with those of Edinburgh. I think the results here are of a highly satisfactory character, and I congratulate them upon the energy they have shown in dealing with this question. I may say our engineer is Mr. Manville, and the system adopted is practically the same system as at Edinburgh. We have a high-tension system and a low-tension system. The low-tension system is in the centre of the borough, and the high-tension is for the outlying districts. The other details are similar. We have the transformers in the same way, and the pressure is about the same. I notice that an extraordinarily low price is charged by the electric lighting committee for the arc lamps in the streets. Perhaps Mr. Newington will tell us whether that is a bit of favouritism, or whether they are able to do it at the price. Our electric lighting committee will not supply the works committee with the light at anything like the price charged in Edinburgh. Therefore I should like to know if they are charging merely cost price. Mr. Newington does not tell us what sum has to be set apart as sinking fund for the repayment of capital, a point of much interest, because it makes a considerable difference as to whether you are able to work the undertaking at a profit or not.

Mr. C. Jones: I have very much pleasure in supporting the vote of thanks to Mr. Newington for his admirable paper. Like my friend, Mr. Lemon, we are also interested in the preliminaries of this electric lighting question, and there are two or three points, information about which will be helpful to both of us, as we are not electricians, though we have sometimes to express an opinion. The first is the importance of having in these statements something like a means of obtaining an average, or a means of comparing the principal points in an electric installation. For instance, Mr. Lemon has told us that the Local Government Board allow fifteen years for repayment of loan. In my own place, Ealing, we are allowed twenty-five years. Mr. Barber will tell you in the case of Islington they are allowed forty-two years. When we attempt to make a comparison as to the probable cost of an undertaking, it is important we should know for how many years the loan is allowed. Then we should also like to know the rate of interest or the basis on which the loans are raised. In the case of Edinburgh we shall probably have that information. In the case of Southampton we may be told the rate of interest which is being paid there.

Mr. Lemon : 2¾ per cent.

Mr. Jones : In Islington I think it is 2⅞ per cent.

Mr. Barber : Under 3 per cent.

Mr. Jones : In Ealing it is 3⅛ per cent. This information is essential in order to get at a comparison of the success of these schemes. We want in all these cases to know the details upon which the calculations have been based; I have felt the want of this information very much. A gentleman gets up in a council meeting, and says, "look at what they are doing somewhere or other," and you have to explain the difference in the interest paid on capital and the difference in the term of years for which the loan has been granted. Whereas, if you had a table drawn up, on which all this information was collated and the figures given, it would very much assist you in dealing with questioners of that kind. Another point I should like to raise is the cost of material. For instance, I was in Manchester a short time since, and on visiting the electric lighting station I said, What is the price of your coal, and the answer I received was (I think) 6*s.* 9*d.* per ton. If you asked me "What is the price of your coal," I should say 12*s.* 9*d.* per ton. Of course, this makes a very material difference in the working expenses, and, as I have before remarked, it would assist us very much, as officials, if we could get these items collected together, and so put a stop to the gentlemen who are so anxious to prove that their officers are making a fearful mistake, because in some other place, where the expenses are perhaps 50 per cent. less, they are making a profit. I should like to ask if Mr. Newington or any of the Members have any experience of free wiring. No doubt it would be a means to an end if this could be carried out. We only deal with it in connection with the churches. When the light is installed in any of our churches they send us in the bill they incur for wiring, and we pay it from a separate fund which is kept at the bank. The authorities of the church repay us the money either in five or seven years. We charge 4 per cent. interest on the money, and as we borrow it at 3½ per cent., we make a small profit on the transaction. We charge the church 4½*d.* per unit for current, instead of 6*d.*, which we charge to other consumers. But as we are doing the work on Sundays, when otherwise the load would be exceedingly small, we are benefiting our works and doing good to the community at large at the same time.

Mr. J. **Parker**: I should like to add my testimony to the value of this paper. I happen to come from a town which has obtained a Provisional Order for electric lighting, and pending the appointment of an electrical engineer, it naturally falls upon the surveyor to do some portion of the preliminary work, however little he may know about it. I have availed myself of the kindness and knowledge of my friend, Mr. Lobley, and I have also studied *Lightning*. In the tables given by *Lightning*, I was very much struck by the position of the Edinburgh electric lighting station, particularly the works cost, which is per unit positively the lowest of any installation conducted by any corporation in the United Kingdom. Whereas the total cost at Belfast comes out at 4·01*d.*, and Salford is as much as 12·57*d.*, the cost at Edinburgh is only 1·13*d.* per unit sold. The works cost varies considerably, Edinburgh, which is again the lowest, coming out at 0·63*d.*, and it runs up as high as 9·35*d.* at Salford, a rather extraordinary difference. The capital outlay per kilowatt produced is also exceedingly favourable, the figure for Edinburgh standing at 87*l.*, which is only beaten by one municipality, Glasgow, where the figure is slightly lower. In all these points one cannot fail to be struck by the success of the Edinburgh undertaking.

Mr. J. **Lobley**: I have pleasure in supporting the vote of thanks to Mr. Newington. The managers of all electric light works in the kingdom look with feelings of mingled envy and encouragement at the success of the Edinburgh works. We cannot help feeling some envy at the very good results they have obtained, but we have also great encouragement to proceed in the same way as they have done here, and extend the mains and reduce the price of current wherever possible. We have done both in Hanley—extended the mains to a very considerable extent for a small town—I think we have more miles of mains in proportion to our customers than anywhere else. This, perhaps, shows that we have increased the mains and reduced the price of current, to such an extent that last year we had a small deficit on the undertaking. Mr. Lemon alluded to the period for loans granted by the Local Government Board. There seems to be no rule in this matter. Our first loan was for twenty-five years, another loan for ten years, and the last for seventeen years. I have sent in an application now for a loan of 4000*l.*, but we cannot tell beforehand for how long it will be granted. The reserve fund mentioned in the paper I take to be in addition to the sinking fund—(Mr. NEWINGTON: Yes). The question of the formation of a reserve fund it appears to me depends entirely upon the period of time granted for the repayment of the loan. To say that Southampton, with a loan for only fifteen years, must put on one side a reserve of 3 per cent. in addition to the sinking fund, and to say that Islington, with a forty-two years' loan, must only make the same reserve, does not seem to me to be reasonable. If the profits permit, of course it is a different matter. The charge of 14*l.* per annum for arc lamps—I presume lamps of 12 ampères —is a very low one. I should like to ask Mr. Newington whether that charge includes the trimming of lamps, the supply of carbon, and all attendance—(Mr. NEWINGTON: Yes). Then there is no doubt it is an exceedingly low charge. We thought in Hanley that we were charging a very low price, and our charge is 19*l.* for 8-ampère lamps burning all night. I should like to ask, with the alternating current, as to the periodicity, and whether there is any trouble with the rectifiers. We have two kinds of arc lamps in use, and one maker's lamps work well, but the others do not. In the centre of the city, customers are supplied at 230 volts pressure. This is the first time I have had so long an acquaintance with lamps at this high pressure. I should like to hear Mr. Newington's opinion as to the life and efficiency of these high-voltage lamps as compared with ordinary lamps.

Mr. KEEP: I should like to ask Mr. Newington whether he finds any disadvantage in the use of a 230 voltage circuit as compared with the usual 110 volts, and also whether the lamps can be maintained with an economical efficiency, or whether the circuit has a tendency to leak, and when you touch a switch you get an unpleasant shock.

Mr. J. Lemon: I think I ought to say, to prevent any misunderstanding, that fifteen years was for the repayment of the first loan of 21,000*l.*, but for the new works the Local Government Board have allowed us twenty-six years.

Mr. A. E. Collins: I should like to ask Mr. Newington whether he has had any experience of explosions of gas which has accumulated in the stoneware casings or iron pipes? We had an explosion of gas of that kind in Norwich, but it did not do any serious damage.

Mr. Smith-Saville: I should like to ask Mr. Newington how long the india-rubber insulation has been in use in Edinburgh? We found in the town I was in last, that this insulation broke down within a period of five years. I notice that the india-rubber insulation at Edinburgh is restricted to the low-tension wires, and that for the high-tension wires a paper insulation is used. Is this because of the rubber insulation having been found defective?

The President: Our thanks are very much due to Mr. Newington for the very valuable paper he has contributed to the Institution. I have seen many papers, but I have never seen one, as Mr. Lemon says, with so much valuable information in so little space.

Mr. Newington, in replying, said: As regards the sinking fund, in Edinburgh we have to repay the loans in thirty years; the interest paid on capital is about 2¾ to 3 per cent. The price of the coal used is 7*s.* 8*d.* per ton. It is known as small nuts, and not of very high heating value. As to free wiring, we have not done anything of that kind. We have not required it; the applications have been so numerous, we can hardly get the consumers connected quickly enough as it is. The reserve fund is over and above the sinking fund. It is limited by Act of Parliament to 10 per cent. of the capital. The continuous-current arc lamps take 10 ampères, except in Princes Street, where they take 15 ampères; the rectified lamps are for 12 ampères. Crompton-Pochin and Brockie-Pell lamps are used. The rectifiers are not thoroughly satisfactory; they want a lot of attention and care. The efficiency of 230 volt incandescent lamps is about 3½ watts per candle. Some last very well indeed, quite as well as the 115-volt lamps, and for efficiency and light are quite as good as ordinary low-voltage lamps. I have not heard of any bad shocks from 230 volts pressure. It may be slightly uncomfortable, but nothing more. The middle wire is earthed, and therefore it is impossible to get more than 230 volts pressure inside a house. As to india-rubber for insulating cables, we have had a good deal of trouble with it, and are now using bitumen. On the high-tension mains we have always used a paper insulation, and it answers very well indeed.

NOTES ON LEITH DOCKS AND NEW WORKS NOW IN PROGRESS.

BY PETER WHYTE, M. INST. C.E.

LEITH is one of the oldest seaports in Scotland, and, notwithstanding the tendency of all old things to decay, it still remains one of the most flourishing ports in the empire. It is first mentioned in historical records in the year 1128, but its authentic history as a port dates from 1329, in which year King Robert the Bruce granted a charter of the harbour and mills of Leith to the City of Edinburgh.

This charter and other royal charters granted in subsequent centuries, and Acts of Parliament too numerous to mention from 1788 onwards, have constituted from time to time the authority and the limits of the jurisdiction of the Commissioners for the harbour and docks of Leith, and define the port as extending from Wardie on the west to "Figgate Burn" on the east, a distance of 3½ miles along the south shore, and extending northwards to the middle of the Firth of Forth.

It would be doubtless interesting to follow the history of the port from the time of its first being granted to the City of Edinburgh to the present time, to follow its course during the five centuries under which it remained as a vassal of Edinburgh, and to consider the somewhat intemperate and interminable series of conflicts which subsisted between the City of Palaces and Towers and their plucky little vassal by the sea.

This would not be quite within the line of thought of a body of men of the engineering profession, whose associations and occupation are more concerned with matter-of-fact everyday work, so the Author will come to times not yet remote, and more practical if less interesting.

Until the beginning of the present century the whole accommodation for shipping at Leith consisted of the harbour, formed in the bed of the Water of Leith, a small stream rising in the Pentlands and which, after a course of some 12 or 14 miles, here joins the Firth of Forth.

Along the banks of this water for nearly half a mile, quay walls had been constructed, at which the vessels were discharged, the depth of water alongside these quays being about 12 feet at high water neap tides, and 16 feet at high water spring tides. The harbour was dry at low water, the bottom of it at its lowest part being about the level of low water of ordinary spring tides.

The entrance to this harbour was not then protected by piers, and great difficulty was experienced by navigators in reaching the harbour, owing to the long stretch of sands and the continued shifting of the outlet of the river towards low water line outside.

Like many other ports, there was a bar at Leith, respecting which Lord Erskine gave vent to his pent up feelings when delayed for want of water.

> "In deep profound surpassing far
> I blest the Edinburgh Bar;
> But muttering oaths between my teeth,
> I cursed the shallow bar at Leith."

This was the position of the harbour at the close of the last century. The trade being then considerable, and the accommodation admittedly inadequate, the Lord Provost, Magistrates and Council of Edinburgh (in whom the harbour was then vested), after having discussed a number of impracticable and fanciful schemes proposed by amateur engineers (fortunately all of which were rejected), wisely agreed to consult the eminent engineer John Rennie, and on his advice in the year 1799 obtained Parliamentary powers for, and subsequently carried out from his designs and under his direction, the first docks at Leith, now known as the East and West Old Docks.

These docks, the former opened in 1806 and the latter in 1817, cost, with their adjoining quays, graving dock and other works incidental to their completion, upwards of 300,000*l.*, a very large sum having regard to the trade at that date. Each dock is 750 feet long, 300 feet wide, and they are entered by a lock 150 feet long, 35 feet wide, and with a depth on the sill of 17½ feet at high water springs. At the time of their construction they were able to accommodate 150 vessels of the class then frequenting the port. The docks are still in excellent condition, and still largely used for the smaller class of vessels.

Having regard to the trade at that period and to the size of vessel, these docks were a gigantic undertaking, and here the Author would like to say what he has said elsewhere before, that notwithstanding the severe criticism and comments which have been made regarding the management of the harbour by the City of Edinburgh in the past, that the Corporation of that time deserves the very greatest credit for having initiated and undertaken works of such magnitude at that period, which remain a tribute to their enterprise and sagacity, and also may be said to have laid the foundation of the prosperity and the future development of the port.

About the year 1835 the finances of the City of Edinburgh became embarrassed. The Corporation had borrowed large sums of money, applied, amongst other purposes, for the construction of the docks, of which about 260,000*l.* was due to the Government practically on the security of the dock rates. The trade had considerably increased. Continued allegations were made that surplus revenues were being applied for civic and municipal purposes and not for the improvement of the harbour as required by the Acts of 1799 and 1826.

An inquiry was instituted by the Government, and a result of this inquiry and of certain negotiations was that the municipal and the mercantile and maritime affairs of Edinburgh and Leith were wholly separated and dissevered. By an Act of Parliament passed in 1838, the harbour and docks were vested in eleven commissioners, of whom three were appointed by the town council of Edinburgh, three by the town council of Leith, and five by the Lords of the Treasury; and it was specially enacted that no member of either town council could be elected a commissioner for the harbour and docks, and this restriction exists at the present time, having been confirmed in successive Acts of Parliament. The commissioners as incorporated took over the whole property and revenues of the harbour and docks, subject to an annual payment of 7680*l.* per annum, of which 2000*l.* was due to the ministers of the city, and which was commuted in 1871 by a payment of 40,000*l.* Of the remaining sum 3180*l.* was due to the "creditors of the City of Edinburgh," 2500*l.* to the University of Edinburgh, and these were commuted in 1896 by a payment of 190,000*l.*

So that the financial tie which bound the docks to the city for the sixty years since the municipal tie was broken, is now also dissolved.

Shortly after the constitution of the commission in 1838, the question of the improvement of the harbour and docks was again under consideration, and the commissioners resolved to consult some of the leading civil engineers of the day. They accordingly obtained reports from Sir William Cubitt and Mr. James Walker, the latter of whom in 1839 recommended the extension of the piers to points very near their present limits, and proposed to dredge the entrance channel so as to give a depth of 12 feet at low water spring tides, and only within recent years this depth has been obtained, and a further depth of 5 feet will shortly be inaugurated.

Several years elapsed before any practical steps were taken to extend the accommodation, but ultimately the consent of the Treasury was obtained in 1847 to the adoption of a plan by Mr. James Meadows Rendel, C.E., London. This led to the construction of the Victoria Dock, and the extension of the piers now existing, the dock being opened for traffic in July 1852. This dock is 750 feet long, 300 feet wide, and 33 feet deep. The entrance is 60 feet wide, and the sill is 6 feet lower than the sill of the old dock, so that it will be seen that a great advance was made in the character of the accommodation, due to the development of steamer tonnage in the previous years.

The trade of the port continued to augment after the opening of the Victoria Dock, and the commissioners resolved to provide still further accommodation.

Hitherto the docks were all on the west side of the entrance channel and harbour. Acting on the advice of Sir Alexander Meadows Rendel, the commissioners now resolved to construct a new dock on the east sands. The works were commenced in 1859, and in 1865 the Albert Dock was opened. This dock is 1100 feet long, 450 feet wide, and 35 feet deep, and is entered through a lock 350 feet long and 60 feet wide, with the sill 2 feet lower than the Victoria Dock and 8 feet lower than the old docks. The available depth of water on the sill is at springs about 26 feet and at neaps about 22 feet.

It may be interesting here to note that it was at this dock that hydraulic appliances were first used in Scotland in working the dock gates and machinery.

The dock gates are constructed of yellow pine trussed beams 21 inches square, with greenheart heel and mitre posts, and greenheart planking below the water line and pine planking above. They are moved by chains working on barrels fixed in the masonry, and actuated by hydraulic engines fixed in pits under the coping.

No sooner was the Albert Dock opened than it became apparent that further dock accommodation would be required, and the construction of the Edinburgh Dock was therefore undertaken. This dock lies to the east of the Albert Dock, with which it is in communication and from which it is entered by a passage 65 feet wide at coping level. The dock is 1500 feet long, 650 feet wide, with a jetty 1000 feet long and 250 feet wide in the centre. The dock is 35 feet deep, the same as the Albert Dock, and was opened in July 1881. The cost of these two docks was upwards of 650,000*l.*

The docks are well equipped with sheds, cranes, rails, &c.

For the protection of goods when discharged there are sheds varying from 60 to 80 feet in width, and some are being extended to a width of 120 feet at the present time. The sheds cover an area of over 13 acres, and they are all floored with whinstone setts or granolithic pavement.

There are altogether 46 hand, hydraulic and steam cranes, fixed and movable cranes varying from 1 ton to 65 tons power, the latter being a steam crane for lifting boilers and heavy machinery on board vessels.

On the top of the jib of this crane an auxiliary jib was recently constructed rising considerably higher, with a power of 18 tons, worked from the intermediate shaft of the machinery for masting vessels.

COAL SHIPMENT.

The facilities for coal shipping consist of one steam coal crane, two hydraulic coaling cranes and three hydraulic coal hoists, all of modern type and construction.

A peculiarity of the coal hoist is that there is only one cylinder and ram, the tipping of the waggon, usually done by a separate ram, being in this case effected by a chain fixed to the front of the cradle which holds it at the required level for the shoot, and the waggon being tipped by the lifting ram being raised to the height necessary to give the angle to discharge the coal from the waggon. The tipping cradle is hinged at the centre, and consequently when tipped a space is left between the front of the cradle and the butt end of the shoot. This space would allow the coal to fall between the cradle and the shoot, but this is prevented by an ingenious arrangement in which by a parallel motion a small subsidiary shoot, level with the floor of the waggon, is projected forward as the cradle rises, and thus effectively "bridges over the gulf."

BRIDGES.

Communication between the two systems of docks on the east and west sides of the harbour is maintained by four bridges, two of which are swing bridges and two bascule bridges. The largest of the swing bridges is 120 feet clear span, and was erected in 1874 at a cost of over 32,000*l*. The bridge is constructed of main braced girders, and carries two lines of railway and roadway, with a footway on each side. The bridge is 215 feet long, and weighs upwards of 700 tons. It turns on a central hydraulic ram 69 inches diameter, and is swung by two rams each 14 inches diameter, with multiplying sheaves and chains. At the time of its construction it was the largest swing bridge in the kingdom, but it is now surpassed by two or three others, notably by the bridge at Connah's Quay, which is 140 feet span, and by the Manchester Canal bridge at Trafford Road, which, although less span, weighs over 1800 tons.

GRAVING DOCKS.

The accommodation for the repairs of vessels consists of six graving docks respectively 382, 338, 300, 266, 180 and 174 feet in length. The latter has been in existence since the old docks were opened, and is stil lin excellent condition, and very useful for the repairs of small vessels and steam trawlers. The largest graving dock, known as the Prince of Wales Dock, was opened in 1860 and cost 60,000*l*.

The water is pumped from all these graving docks by turbine or centrifugal pumps of such power that the docks can be emptied in about two hours.

Shipbuilding and Ship Repairs.

Shipbuilding has a history at Leith. It was inaugurated by James IV., who formed a dockyard at Newhaven (then called "Our Lady's Port of Grace"), and in 1511 ordered the building of the *Great Michael*, a war vessel 240 feet long, 36 feet beam, and which "within the walls" was 10 feet thick, with massive sides of oak. The building of this vessel is said to have "wasted all the woods in Fife (except Falkland Wood), besides timber that came from Norway." This vessel "had 300 mariners, six score gunners, 1000 men of war, besides captain, skippers and quartermasters." The *Great Michael* was afterwards sold or presented to Louis XIII.

The patent slip for the repair of vessels was invented at Leith by Messrs. Morton & Co., a firm still in existence; and Messrs. Menzies & Co., who built the renowned *Sirius*, the pioneer of Atlantic steam navigation, in 1837, have occupied premises at the harbour for over 100 years.

There are several other shipbuilding and repairing yards, the largest being that of Messrs. Ramage and Ferguson, who have acquired distinction as the builders of some of the finest steam yachts afloat.

Trade and Finance.

The cost of the harbour and docks up to the present time has been over 2,000,000*l.*, and the amount of the existing debt is 436,000*l.*

The revenue last year was 106,000*l.*, of which over 10,000*l.* was derived from rents of ground, warehouses, feu duties, &c.

The number of vessels arriving at the port during the year was 6046, with an aggregate tonnage of 1,814,435 net register tons, of which 5215 vessels of 1,678,784 tons were steamers.

The total imports and exports were over 2,500,000 tons, of which fully one-half arrived at or was despatched from the ship's side direct in railway waggons, rails being laid on every quay in direct communication with the Caledonian and North British Railways, thus affording rapid and efficient means of transit to all parts of the country.

Goods imported and exported are of great number and variety, there being upwards of 400 classified articles, and probably an equal number unclassified.

The rates on vessels vary from 2*d.* per register ton on all coasting vessels to 5*d.* for Continental, 7*d.* for Baltic, and 10*d.* for American and eastern vessels. But there are important concessions in all cases after two or three voyages of a vessel in any one year, and all vessels pay only 2*d.* per ton after eight voyages. The rates on goods vary from 1*d.* per ton on coal to 8*d.* per ton on grain, flour, timber, hemp, flax, &c.

LIGHTING AND WATER SUPPLY.

Water is supplied to the vessels and works by the Edinburgh and District Water Trust, by arrangement with the commissioners. The latter body obtain the water in "bulk," and distribute it to the vessels and collect the charges thereof. The commissioners have water mains on every quay, the aggregate length of mains over 3 inches diameter being about 6 miles. The quantity of water used is about 55,000,000 gallons per annum.

There are also about 6 miles of gas mains, and the lighting by gas necessitates the use of about 420 large Bray and other lamps, and the consumption of about 7,000,000 cubic feet of gas per annum, in addition to 60 electric 10-ampère arc lamps. The plant supplying the current for the electric light is situated at the west end of Victoria Dock, and of which there will probably be a considerable extension in the near future, in view of the completion of the new dock works now in progress.

NEW WORKS.

The new dock works now in course of construction, necessitated the reclamation of an area of about 80 acres of the foreshore lying to the north or seaward side of the Albert Dock.

This reclamation was effected by a sea wall of somewhat unusual design. It consists of a mound of hand-packed rubble stone, 30 feet wide at the base and 9 feet at the top, the sea face of which is covered with large concrete blocks, each 6 feet long and 4 feet wide. The whole of the wall is laid on the surface of the sand, which is dry at low water of spring tides, and the face of the wall has a slope of about $\frac{3}{4}$ to 1. A row of pine sheet piling was driven down to the clay along the back of the wall, and a row of greenheart sheet piling was driven to a depth of 8 feet into the sand at the toe of the wall. The result was that the sand between these rows of piling became quite firm, and some small stone being spread over it made it resemble a road. The laying of the large concrete toe blocks, each weighing about 14 tons, was thus easily and expeditiously accomplished. Above the sheet piling the wall is backed with clay puddle up to high water line, to make the sea wall "water-tight," so that it became a cofferdam to exclude the water from the reclaimed area. It has in all respects proved satisfactory. The clay puddle was kept in position by a backing of dry stone, earth, sand, &c. The wall is surmounted by a parapet constructed of 6 to 1 cement concrete *in situ*, carried up to 15 feet above high water ordinary springs. The wall was completed in 1896, and has stood through the gales of two winters quite satisfactorily.

The dock now being constructed within the reclaimed area, from which the water was excluded in June 1896, is 1100 feet long, 550 feet wide and 40 feet deep. The length can easily be increased to 2000 feet at small expense in future. The dock is being surrounded with walls of solid masonry set in cement mortar, and carried down into the boulder clay 4 feet below the bottom of the dock. The walls are 20 feet thick at the base and 9 feet at the top.

The face is formed of squared stones close jointed and with a batter of $\frac{1}{2}$ an inch per foot. The back sets off 3 feet at 11 feet from the top, and again 4 feet at 19 feet below coping. From this point to the bottom the back of the wall is vertical.

The walls are all finished with granite coping 3 feet wide in the dock and 4 feet wide in the lock and basin, and all 1 foot 6 inches thick.

The dock will be entered by a lock 350 feet long between the sills, 70 feet wide, and 38 feet deep from coping to sill. This will give a depth of water over the sill at ordinary springs of 30 feet 6 inches, and at neaps of about 25 feet 6 inches; at equinoctial springs the depth over the sill will be about 33 feet.

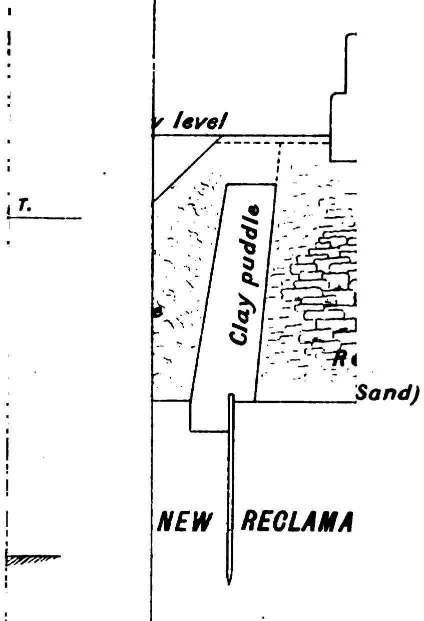
The lock walls are being constructed of masonry similar to the dock walls. The invert is of cement concrete gauged 6 to 1, and is to be covered with squared whinstone 12 inches thick. All the hollow quoins, sills, roller path stones, and sluice stones are of Aberdeen granite. The culverts are each 6 feet high and 4 feet wide, and the sluices are to be of greenheart timber, and to be raised and lowered by direct-acting hydraulic rams fixed to the masonry of the wall. A stop groove of granite is constructed on each side of the sluices, so that by inserting dummy paddles temporarily the sluices can easily be examined or repaired if necessary.

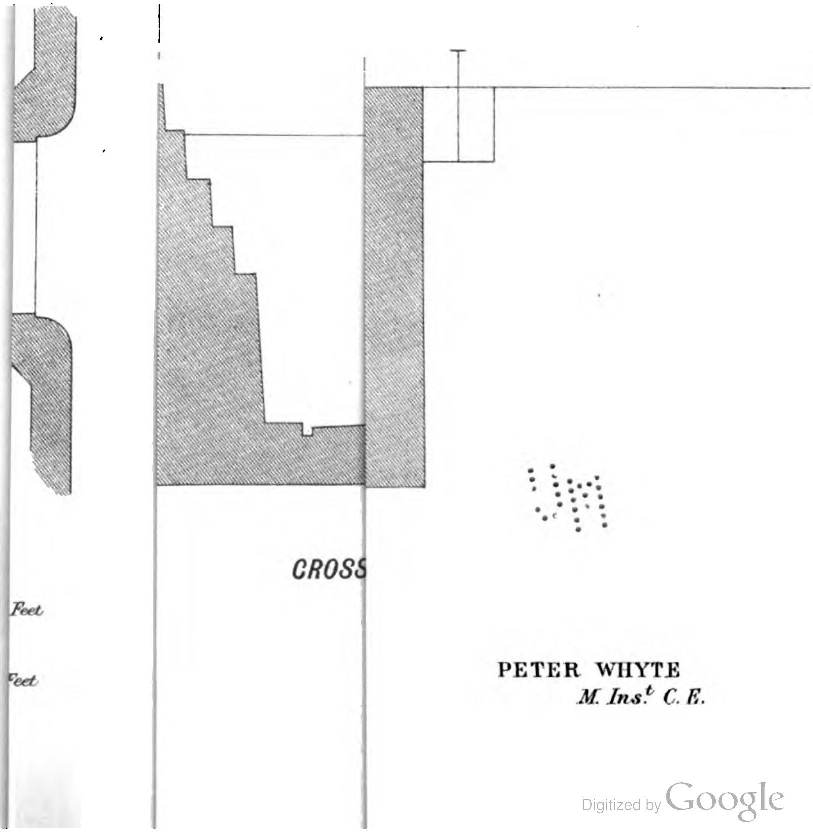
The dock gates are being constructed on the flotation principle, wholly of steel and fine Yorkshire iron, with greenheart sills and heel and mitre posts. Each pair of gates, with the requisite pivots and roller paths, will weigh about 292 tons. The gates will be opened and closed by direct-acting pistons with a piston rod attached to a horizontal lever on the top of the gate. This lever is hinged to the anchor block of the gate at one end, and the other end is fixed to a bracket on the top of the gate.

A passage 60 feet wide and 36 feet deep will form a communication between the new dock and the Albert Dock. The construction is similar to the entrance lock. It will be fitted with a single pair of gates also of the flotation type, but the machines for opening and closing will be fixed on the back of the walls, and will actuate the gates by means of chains passing over pulleys at the heel post.

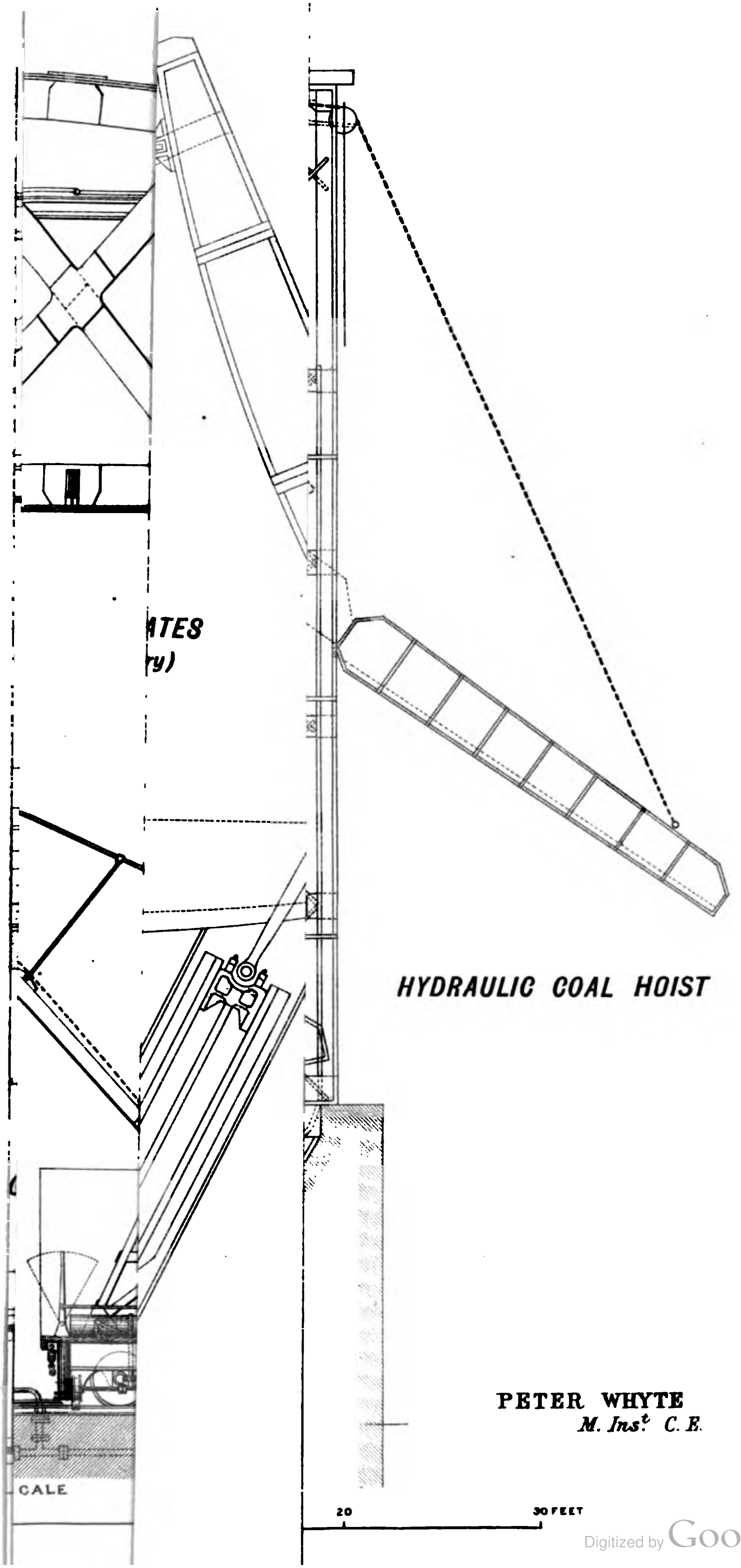
The value of this passage will be obvious, as besides enabling vessels to pass from one dock to another, it provides practically a duplicate entrance from the harbour to the whole system of the docks on the east side of the harbour, a point of manifest importance in the working of the traffic.

Across this passage a swing bridge has been constructed. The bridge is on the skew, and is 132½ feet long over all, 28½ feet wide, and has two lines of roadway and rails, and a footpath on each side. This bridge is formed of two mild steel plate main girders with cross girders, and with the roadway of timber. It weighs 350 tons, and is carried on a central hydraulic pivot. The tail end is carried on two rollers travelling on a segment laid in the masonry. The turning of the bridge is effected by a pair of hydraulic rams with multiplying sheaves with chains attached to a quadrant





PETER WHYTE
M. Ins.^{t} C. E.



HYDRAULIC COAL HOIST

PETER WHYTE
M. Inst^{t} C. E.

under the bridge, one for opening and one for closing the bridge. A similar bridge is now under contract to be placed across the entrance lock, Albert Dock, so as to afford an additional means of communication to the south side of the new dock.

It is expected that the dock will be opened for traffic by the end of the year 1900.

The equipment is not yet decided upon, but it may be assumed that the sheds, cranes and other appliances will be of the best construction and highest efficiency, so as to place Leith in the front rank of modern, as it was for many years in the front rank of ancient ports.

DISCUSSION.

Mr. W. **Harpur**: It affords me very great pleasure in proposing a vote of thanks to Mr. Whyte for his very interesting paper. I do so as a very old friend of Mr. Whyte, because many years ago when I was deputy engineer of Cardiff, he was deputy dock engineer, and much of his training as a dock engineer was obtained in the town which I represent. Most of us will not be interested in docks, they do not come within the province of a municipal engineer. But the very first work described by Mr. Whyte, the construction of a sea wall, is a class of work many of us have to deal with, and the illustrations will be of very great value to us. There is also the question of the bridge, which is accompanied by a beautiful illustration, and will be exceedingly useful to some of us who have bridges to construct. I am sure the paper will form a very valuable part of our volume of Proceedings this year.

Mr. J. **Patten Barber**: I have very great pleasure in seconding the vote of thanks to Mr. Whyte. The part of the paper which principally interests me is the wall which has been constructed for the purpose of reclaiming some of the foreshore. I think we may fairly describe that wall as of novel construction, as Mr. Whyte has done. It is ingenious, and I think daring. I use that word advisedly, and I hope its meaning will not be misunderstood; I did not say reckless, it is daring, it is bold. I should like to know with what he has protected the sheet piling—it looks somewhat like concrete bag work—and whether there has been any indication of these stones—or whatever they may be—being rolled away by the action of the waves; also, were the concrete blocks forming the toe of the wall constructed in the open. The boldest part of the construction seems to be the formation of the heart of the wall in dry rubble, and it is a question whether, when this clay puddle has been put in at the back, any excess of water brought into the heart of the wall by the flow of the tide, may not have a tendency to break up the concrete face by its hydrostatic pressure. It seems to be a bold piece of work, but as Mr. Whyte tells us, it has been very successful; one need not find fault with its boldness when the work has proved absolutely successful. It is also very ingenious, and I feel perfectly confident that no one but a man who knew what he was doing would have had the courage to adopt this method of construction. It is very cheap and very successful. I particularly wish to draw attention to the way in which the foundation was prepared for laying the toe of the wall upon the sand. I once had occasion to design a retaining wall 60 feet high, and the foundation was somewhat similar to the sand on which this wall has been constructed, and I intended, had the wall been constructed, to have placed hard burnt clinker on the soft foundation to make it somewhat harder than it was, and assist in consolidating the soft clay and prevent its spewing up under the weight of the wall upon it. I have pleasure in seconding the vote of thanks, which I think is highly deserved.

The vote of thanks having been unanimously accorded,

Mr. P. Whyte, in reply, said: Just a word in reference to the question raised by Mr. Barber. They are rough stones laid at the toe of the wall, and not one has shown the slightest sign of movement at any time. The object of this was to prevent the backwash washing away the sand. Of course, as to the boldness of the design, it was not arrived at in one day. A smaller wall was built on the same design, and as we got on we became bolder. The object of the sheet piling was to keep the sand in place; without that we could not have got the sand firm enough to have the blocks laid. Then I recommended sheet piling, and that overcame all the difficulty, and the construction became so strong that you could drive trucks along it.

On Thursday evening (June 30), the Members dined together at the Royal Hotel, Edinburgh.

On Friday, at the close of the indoor business of the Meeting, the Members were entertained to luncheon at the Royal Hotel, by Mr. W. N. Colam, the engineer for the Edinburgh Cable Tramways. In the afternoon the Members were divided into two parties, for the purpose of visiting a number of the municipal and other features of the city. The first section visited and inspected the Artisans' Dwellings at Cowgate; the Electric Lighting Station in the west end of the city, full particulars of which are given in Mr. Newington's paper. The Tollcross Cable Tramway Power Station was next visited, where Mr. Colam fully explained the details of this station, now in course of completion. The party then proceeded to the McEwan Hall, a magnificent feature of Edinburgh's architectural acquisitions, and thence to the Public Library. The second section visited the Powderhall Refuse Disposal Works, the Chancelot Roller Flour Mills, the Shrubhill Cable Tramway Power Station, and the Leith Docks, complete details of which are given in the paper read at the Meeting by Mr. Peter Whyte.

On Saturday, the third and last day of the Meeting, two parties were again formed, one of them visiting the Forth Bridge, while the second visited and inspected St. Giles' Cathedral, Holyrood Palace and other places of local interest

APPENDIX.

PAGE
List of Books of Statistics at Offices of the Association 342
Examinations 348
Board of Examiners 358
Certificated Candidates 359

Memoirs of Deceased Members 365

RETURNS, OR BOOKS OF STATISTICS

On the following subjects lie at the Offices of the Association, 11 Victoria Street, Westminster, S.W., and are open to the inspection of Members.

DRAINAGE (HOUSE).

Information from 31 towns. Compiled by J. Atkinson, A.M. Inst. C.E., Stockport.

HORSES (COST OF KEEPING).

Information from 29 towns. Compiled by M. Petree, A.M. Inst. C.E., Grimsby.

LIGHTING (ELECTRIC).

Information from 38 towns. Compiled by J. W. Brown, A.M. Inst. C.E., West Hartlepool.

Information from 88 towns and 10 London vestries. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth.

Information from 58 towns. Compiled by W. A. Davies, A.M. Inst. C.E., Aston Manor.

Information from 36 towns. Compiled by E. J. Silcock, A.M. Inst. C.E., King's Lynn.

LIGHTING (GAS).

Information from various boroughs. Compiled by J. W. Bradley, A.M. Inst. C.E., Nelson.

Information from 38 districts as to undertakings in the hands of Local Authorities. Compiled by P. Ross, A.M. Inst. C.E., North Bierley.

LIGHTING (PUBLIC STREET).

Information from 21 towns. Compiled by A. H. Campbell, A.M. Inst. C.E., Canterbury.

Information from 54 towns. Compiled by C. C. Smith, Dalton-in-Furness.

PAVEMENTS (COMPARISON OF LIFE AND COST OF GRANITE AND GRITSTONE).

Information from 33 towns. Compiled by C. F. Wike, M. Inst. C.E., Sheffield.

PAVEMENTS (TAR MACADAM).

Information from 51 towns. Compiled by A. E. Collins, M. Inst. C.E., Norwich.

Information from 72 towns. Compiled by J. Hall, A.M. Inst. C.E., Cheltenham.

Information from 19 towns. Compiled by E. A. Stickland, A.M. Inst. C.E., New Windsor.

PRIVATE STREET IMPROVEMENTS (CONSTRUCTION OF WORKS OF).

Information from 49 towns. Compiled by W. J. Newton, A.M. Inst. C.E., Accrington.

PUBLIC BATHS AND WASHHOUSES.

Information from 44 towns. Compiled by P. Edinger, Frome.

REFUSE (COLLECTION OF).

Information from 89 towns. Compiled by J. Price, A.M. Inst. C.E., Toxteth Park.

REFUSE (DESTRUCTORS).

Information from 36 towns. Compiled by W. Brooke, A.M. Inst. C.E., Richmond.

REFUSE (DISPOSAL OF).

Information from 39 towns. Compiled by J. Price, A.M. Inst. C.E., Toxteth Park.

REFUSE (REMOVAL OF).

Information from 87 towns. Compiled by C. R. Fortune, Bath.

ROADS (MAINTENANCE OF MAIN IN NON-COUNTY BOROUGHS).

Information from 83 towns. Compiled by W. H. Smith, A.M. Inst. C.E., Carlisle.

ROADS (STEAM ROLLING OF).

Information from 42 towns. Compiled by A. W. Parry, A.M. Inst. C.E., Reading.

ROADS (WATERING OF).

Information from 65 towns. Compiled by W. Dawson, A.M. Inst. C.E., Leyton.

SCAVENGING (STREET).

Information from 87 towns. Compiled by C. R. Fortune, Bath.

SEWAGE (DISPOSAL OF).

Information from 53 towns. Compiled by J. H. Cox, M. Inst. C.E., Bradford.

SEWAGE (PURIFICATION OF).

Information from 41 towns. Compiled by H. Richardson, A.M. Inst. C.E., Oldbury.

SEWERS (VENTILATION OF).

Information from 81 towns. Compiled by J. T. Earnshaw, A.M. Inst. C.E., Ashton-under-Lyne.

SHONE'S HYDRO-PNEUMATIC SYSTEM (WORKING OF).

Information from 20 towns. Compiled by E. Buckham, M. Inst. C.E., Ipswich.

SLAUGHTER-HOUSES.

Information from 22 towns. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth.

TRAMWAYS (ELECTRIC).

Information from 34 American and Canadian towns. Compiled by Chas. Mayne, A.M. Inst. C.E., Municipal Engineer, Shanghai.

TRAMWAYS (STREET).

Information from 48 towns. Compiled by J. E. Swindlehurst, A.M. Inst. C.E., Burton-on-Trent.

WATER RATES.

Information from 25 (northern) towns. Compiled by A. W. Lawson, A.M. Inst. C.E., Borough Engineer, Rawtenstall.

WATER SUPPLY (DIAMETERS AND DEPTHS OF MAINS FROZEN IN 1895).

Information from 55 towns. Compiled by E. Pritchard, M. Inst. C.E., Birmingham.

WATER SUPPLY (FOR DOMESTIC AND GENERAL PURPOSES.)

Information from 111 towns. Compiled by J. T. Eayrs, A.M. Inst. C.E., West Bromwich.

WORKMEN'S DWELLINGS.

Information from 72 towns. Compiled by J. W. Cockrill, A.M. Inst. C.E., Great Yarmouth.

WORKMEN'S WAGES.

Information from various Metropolitan Public Bodies. Compiled by J. R. Dixon, A.M. Inst. C.E., Vestry Surveyor, St. Leonard, Shoreditch.

Information from 39 towns. Compiled by R. H. Haynes, Newport, Mon.

SPECIAL REPORTS.

British Fire Prevention Committee, Reports of.

Cable Tramways, Report on. Borough Surveyor, Bradford. 1890.

Cement Admixtures, Report on. London Chamber of Commerce.

Collection and Disposal of House Refuse, Report on. Surveyor to Urban District Council, Wimbledon. 1891.

Disposal of Refuse, &c., in Cities of Melbourne and Adelaide, Report on. City Surveyor, Sydney. 1891.

Drainage of Frognall and Oak Hill Park, Hampstead, Report on. 1892.

Electric Light in Cotton Mills, Report on. Borough Engineer, Blackburn.

Gas Producing Plant and Gas Engines for Leyton Electricity Station, Report on. Prof. H. Robinson.

Lighting the City of Liverpool by Electricity, Report on. City Engineer, Liverpool. 1892.

Main Sewerage Works, Report on. Borough Engineer, Blackburn.

Municipal Government of Large Cities, Report on. City Surveyor, Sydney.

Scavenging, &c., Report on. Vestry Surveyor, St. Leonard, Shoreditch.

Sewage Disposal Committee, Report to the. By City Surveyor of Carlisle. 1896.

Sewage Disposal, Report on. Borough Surveyor, Bradford.

Sewage Disposal Works, Report on. Borough Engineer, Blackburn.

Steam Road Rolling, Report on. County Surveyor, Hereford.

Town Refuse Destructors, Report on. By Borough Surveyor of Ipswich. 1896.

Tramway Traction, Report on. City Engineer, Birmingham.

Tramway Traction, Report on. City Surveyor, Bradford.

Tramway Traction, Report on. City Surveyor, Sheffield.

Treatment and Destruction of Refuse, Report on. City Surveyor, Sydney.

Water Supply, Report on. By Director of Public Works, Hong Kong. 1896.

Water Works, Report on. By Borough Engineer, Blackburn.

Wood Paving and Cube Sett Paving, Report and Specification. City Surveyor, Sydney.

Wood Paving, Report on. City Surveyor, Melbourne.

Wood Paving, Report on. Vestry Surveyor, St. George, Hanover Square.

PAMPHLETS.

Bye-laws of the Audenshaw Local Board.

Description of the Blackburn Fever Hospital. By J. B. McCallum, Borough Engineer, Blackburn.

Description of the Sewage Disposal Works of the County Borough of Burnley. By F. S. Button.

Evidence *re* Birmingham Corporation Water. James Mansergh.

Filtration of Sewage. By Geo. W. Rafter.

Genesee River Storage Surveys. By Geo. W. Rafter.

Handbook of the Clinical Research Association. 1896.

Hydraulics of the Hemlock Lake Conduit of the Rochester Water Works. By Geo. W. Rafter.

Irish Grand Jury System. County Surveyor, Co. Tipperary.

Means of Regulating Vehicular Traffic. City Surveyor, Sydney. 1891.

Measures for Restricting the Use and Waste of Water in force in Rochester, N.Y. By Geo. W. Rafter.

Meteorology of Nottingham. Also Chart showing the relation of the Number of Deaths from various causes to Meteorological Conditions for 1891–1897. Compiled by A. Brown, M. Inst. C.E., Borough Surveyor, Nottingham, and Philip Boobbyer, M.B.

Sewerage of Geneva. By Geo. W. Rafter.
Some Recent Advances in Water Analysis for the Detection of Sewage Contamination. By Geo. W. Rafter.
Torquay Water Works. Water Engineer, Torquay.

ANNUAL REPORTS.

Aston Manor, Surveyor to Urban District Council. 1896–97.
Bedfordshire, County Surveyor of. 1894–95.
Fulham, Surveyor to the Vestry of. 1890–91.
Hong Kong, Director of Public Works. 1895–96.
Johannesburg, Town Engineer of. 1894–96.
Kensington, Vestry Surveyor of. 1894–95.
Middleton, Borough Surveyor of. 1898
Montreal, City Surveyor. 1890–91.
Paris, City Engineer. 1896–97.
Rochester, Executive Board of. 1888–90.
Shanghai, Municipal Engineer of. 1894–98.
Southend-on-Sea, Medical Officer of Health. 1896.
Stockport, Borough Surveyor of. 1891–98.
Stockport, Borough Surveyor to the Highways and Sewers Committee. 1890–92.
Sydney, City Surveyor. 1889–95.
Sydney, Metropolitan Board of Water Supply and Sewerage. 1891.
Walsall, Borough Surveyor of. 1891–92.
Wednesbury, Borough Surveyor of. 1894–95.
Willesden, Surveyor to Urban District Council. 1890–97.

VOLUNTARY EXAMINATIONS.

SYLLABUS.

The Incorporated Association of Municipal and County Engineers undertake the holding of Voluntary Pass Examinations for Candidates for Surveyorships under Municipal Corporations and the Local Government Acts.

Two or more Examinations are held in each year, one at least, in April, in London, and one at least, in October, in some provincial town to be fixed on by the Council, and duly advertised beforehand.

The Examinations are by written papers and *vivâ voce*, upon the four following subjects:—

1st. Engineering as applied to Municipal Work.
2nd. Building Construction and Materials.
3rd. Sanitary Science as applied to Towns and Buildings.
4th. Municipal and Local Government Law as relating to the Work of Municipal Engineers and Surveyors.

Candidates are not necessarily required to answer all the questions set in each paper, though not less than four must be taken: marks are given for all questions correctly answered. The *vivâ voce* examination is held after the written papers are all sent in, and is chiefly directed to the further elucidation of the answers to the papers on each subject, and to such practical points as fairly arise therefrom.

The Examinations occupy two days, and the arrangements are, as far as possible, as follows:—

First day	..	10	to	1	..	Engineering.
„	..	2	„	4	..	Sanitary Science.
„	..	5	„	7	..	Municipal and Local Government Law.
Second day	..	9	„	11.30		Building Construction.
„	..	12	„	4	..	*Vivâ voce* Examination.

Fifty per cent. of the total number of marks given are required to constitute a pass.

Each candidate must fill up a Form of Application, to be obtained from the Secretary, and returned in accordance with date given thereon.

Candidates must have attained their twenty-second birthday.

The fee for each Examination is *4l. 4s.*, two guineas to be paid on application, and the balance on the day of examination. Should the candidate fail, he is entitled to present himself again at the next, or any subsequent Examination, on payment of *2l. 2s.*, one guinea to be paid on application and one guinea on the day of Examination.

No further charge is made to the candidate than the fees above mentioned.

Candidates who do not present themselves for Examination forfeit their entrance fee.

Successful candidates receive a Certificate in the form of a "Testamur," signed by the Examiners for the time being, and countersigned by the President and Secretary of the Association in Council.

No information as to the result of an examination, beyond the fact of a candidate having "Passed" or "Failed" is given.

Any inquiries referring to the examinations should be directed to Mr. THOMAS COLE, Secretary to the Association, 11 VICTORIA STREET, S.W.

SUBJECTS OF EXAMINATION.

I.—ENGINEERING AS APPLIED TO MUNICIPAL WORK:
- A. Land Surveying and Levelling.
- B. Hydraulics.
- C. Sewerage and Sewage Disposal Works.
- D. Water Supply.
- E. Road Making.

II.—SANITARY SCIENCE AS APPLIED TO TOWNS AND BUILDINGS:
- A. Ventilation of Buildings.
- B. Scavenging and Disposal of Refuse.
- C. House Drainage.
- D. Disinfection.

III.—MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

IV.—BUILDING CONSTRUCTION: STRENGTH OF MATERIALS:
- A. Materials.
- B. The Construction of Public and Private Buildings.
- C. Building Bye-laws.
- D. Public Baths and Hospitals.

NOTE.—The Examiners do not recommend any particular text-books, as it is desired to make the Examinations rather a test of the candidate's practical knowledge of the subjects generally, than to find his acquaintance with any particular book or books.

EXAMPLES OF QUESTIONS.

The following are the Examination Papers set to the candidates at the Twenty-fourth Examination, held at the Council House, Birmingham, on the 1st and 2nd October, 1897, and serve as examples of questions asked under the different sections.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner: E. Pritchard, M. Inst. C.E., F.G.S.

LAND SURVEYING AND LEVELLING.

1. Describe a Gunter's chain; state what precautions are necessary to ensure accurate work.
2. Give the formula for calculating the area of a triangular piece of land, with sides respectively, 300 chains, 236 chains, and 126 chains long; state the area, in acres and decimals of an acre.
3. A 12-inch pipe sewer has a gradient of 1 in 237·33; the reduced invert level at its outlet being − 0·3; what would be the reduced invert level at a distance of 2700 feet from its outlet end?

HYDRAULICS.

4. Water flowing in an open culvert, having a sectional area of 10 square feet, is observed to possess a surface velocity of 45 feet per minute; state the rate of discharge in gallons per twenty-four hours.
5. A pressure of 700 lbs. to the square inch is required in a hydraulic accumulator, the cylinder of which is 15 inches in diameter; give the total resistance in lbs. weight that the engine has to pump against (ignoring friction).

DRAINAGE AND SEWERAGE.

6. Make a sketch of a manhole to a 15-inch diameter earthenware street sewer, at a total depth of 8 feet to the sewer invert; state materials to be used, and give an approximate estimate of cost of the manhole.
7. Give a reliable formula used for calculating the discharge of circular sewers; state the minimum self-cleansing gradients necessary for 20-inch, 18-inch, 15-inch, 12-inch, and 9-inch diameter straight-line sewers respectively, when running half-full.

WATER SUPPLY.

8. Give Hawkesley's rule for calculating the total number of days for storage purposes in open catch-water reservoirs in England; also state what is the mean average evaporation per day.

9. A town requires an average of 200,000 gallons of water per twenty-four hours. What principle should be adopted in settling the diameter of the supply main, and state what should be the maximum velocity in the pipes?

10. State the quantity of water required per head of the population in a water-closeted non-manufacturing town, and describe means for preventing waste.

ROAD MAKING.

11. Give a brief description for the formation of a 60-feet macadamised road (highway), inclusive of footpaths, describing the various materials to be used.

12. Sketch a cross section of a wood-paved street, 45 feet wide between kerbs, showing the required cross falls, and state what provision should be made for expansion of the wood; include in the sketch the footpaths complete. State an approximate estimate of cost per square yard complete.

SUBJECT:—BUILDING CONSTRUCTION.

Examiner: A. M. Fowler, M. Inst. C.E.

VENTILATION.

1. Name some of the best known methods for ventilating rooms in dwelling houses.
   (*a*) In public halls, i.e. theatres or concert halls.
   (*b*) In technical schools, especially chemical class rooms and laboratories.

FIRE-PROOF FLOORING.

2. Name some of the best methods of construction of fire-proof flooring. Give sketch.
   (*a*) What is understood by corrugated iron flooring, and how should it be applied to floor construction? Give sketch.
   (*b*) Show by sketch the mode of trimming floor construction to prevent beams entering the walling of chimney flues.

HEATING AND WATER SUPPLY.

3. State the principle of constructing hot water supply for bath and other purposes. Give sketch, showing how the circulation is obtained, with positions of the boilers, cistern, &c.
    - (*a*) State some of the best known systems for heating dwelling houses, stating how the high and low pressure is respectively applied.
    - (*b*) State the best methods for prevention of frost to cold water cisterns in connection therewith.

CHIMNEYS.

4. Give sketch of construction of a mill chimney, say 90 feet high, with inside proportions, and materials to be used in its construction.
    - (*a*) What is the best proportion for chimney flues for dwelling houses? State how they should be constructed in finish.
    - (*b*) State how chimney flues should be formed for a four-story building. Give an elevation of the lines of flues.

SUBJECT :—SANITARY SCIENCE.

Examiner: James Lemon, M. Inst. C.E., F.R.I.B.A.

1. How much fresh air is required per hour to keep an inhabited room healthy?
    - (*a*) Adult males in repose.
    - (*b*) In gentle exertion.
    - (*c*) In hard work.
2. State what means you would adopt to warm and ventilate a ward in an infectious diseases hospital.
3. What are the characteristics of drinking-water derived from?
    - (*a*) Springs; (*b*) deep wells; and (*c*) gathering grounds. What kind of storage reservoirs should be used, and what kind of pipes in each case?
4. What are the advantages and disadvantages of intermittent and constant supply, and what quantity per head is required for purely domestic purposes?
5. What is the velocity and discharge of an 18-inch pipe running half full, 2000 feet long, with a gradient of 1 in 264?

6. What cubic capacity would you advise for precipitation tanks for a population of 10,000, with a water supply of 25 gallons per head.

7. What chemicals, and what quantity per diem, for 10,000 persons?

8. If 20 tons of sewage sludge containing 90 per cent. of moisture be reduced to 15 per cent. of moisture, what would be the weight of the solids remaining?

SUBJECT:—PUBLIC HEALTH ACTS AND RIVER POLLUTION ACTS, AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

Examiner: John T. Eayrs, M. Inst. C.E., F.S.I., &c.

1. What power has a local authority to enforce the drainage of undrained houses? Set out fully the section of the Public Health Act relating thereto.

2. Name three cases where the interpretation of "drain" and "sewer" has been dealt with in the Superior Courts, giving concisely the circumstances of each case and the decision.

3. What are the powers, duties and liabilities of a Local Authority as to alterations to or discontinuance of sewers?

4. What power has a Local Authority to enforce provision of closet accommodation for houses? and Has a Local Authority power to make a general order that none but water-closets will be allowed by them? Name a case in which this point has been decided, and the circumstances relating thereto.

5. What are the powers of a Local Authority with respect to the cleansing of offensive watercourses or ditches forming the boundary of two districts?

6. Where any person complains to the Local Government Board that a Local Authority is in default in the performance of its duty as to sewerage or water supply, what powers have the Local Government Board, and how enforced?

7. What is a "place of public resort" as defined by the Public Health Act Amendment Act, 1890, and what are the duties of a surveyor in relation thereto?

8. What is the duty of a Surveyor prior to serving notices to make a Private Street under Sec. 150, Public Health Act, 1875, and also under Sec. 6 of the Private Street Works Act, 1892?

9. What is a—
(*a*) Public Building, (*b*) Warehouse, (*c*) Domestic Building, (*d*) Dwelling House as defined in the Model Bye Laws?

The following are the Examination Papers set to the candidates at the Twenty-fifth Examination, held at the Institution of Civil Engineers, Westminster, on the 1st and 2nd April, 1898, and serve as examples of questions asked under the different sections.

SUBJECT:—ENGINEERING AS APPLIED TO MUNICIPAL WORK.

Examiner: A. M. Fowler, M. Inst. C.E., F.S.I.

1. WATER WORKS.

(*a*) Which is the best known form of constructing dams for valley reservoirs or embankments, say, forty feet high? Give sectional sketch.

(*b*) State the inclinations of the inner and outer slopes.

(*c*) Show how the flood water should be passed off. Give sketch.

(*d*) State formula for calculating the pressure of water on the embankment, say, when the reservoir is full, at twenty feet below top water line.

2. TRAMWAYS.

(*a*) What is the best form of rail for cars drawn by horse power? Give sketch.

(*b*) Where should the vertical line of pressure or weight come on the rail? Give sketch.

(*c*) How should the paving be laid next the rail? Give sectional sketch, showing foundation and surface of road next the rail.

(*d*) About what weight per yard should a tram rail be for horse traction?

(*e*) How should the joints of the rails be formed? Give sketch.

3. IRON AND STEEL WORK.

(*a*) To what tensile strain per square inch in section should wrought iron be tested?

(*b*) To what tensile strain per square inch in section should steel be tested?

(*c*) Which is the best way of applying a test with regard to the torsion of wrought-iron plates or bars?

(*d*) Which is the best way of applying a test with regard to the torsion of steel plates or bars?

(*e*) Which is the best proportion of depth for a wrought-iron single-web girder with regard to its length, for the economical application of metal?

SUBJECT:—SANITARY SCIENCE.

Examiner: Francis J. C. May, M. Inst. C.E., F.S.I.

1. Describe the regulations of the model bye-laws as to house drainage, the ventilation of the drains, and their connection with the public sewer.

   Illustrate the same by drawing sectional diagrams respectively of a three-storied detached house, and also of one in a terrace where the drain must necessarily be brought through the house.

2. Describe the tests you would apply to discover any defects in a drain soil pipe or internal fittings.

3. What do you consider the minimum fall that should be given to a house drain to render it self-cleansing?

4. What are the general principles to be observed in preparing a drainage scheme for an inland town of 30,000 inhabitants?

5. How would you determine the maximum dry weather quantity of sewage per day, and what additional provision would you make for rainfall when deciding upon the required sizes of sewers?

6. What variation would you make in your calculations under different circumstances, e.g. where the gradients are flat, or where the gradients are steep?

7. What do you consider should be the minimum velocity in a sewer to render it self-cleansing?

8. Give a description of the application of sewage to land on the irrigation system, under varying conditions or kinds of soil and subsoil; the area of land required per 1000 of population; and define the difference in principle between irrigation and land filtration.

9. Describe the conditions which would render a separate system of sewers advantageous, i.e. one set for the rainfall, and another for the sewage.

10. State under what conditions a system of chemical treatment would seem more practicable than broad irrigation or land filtration; and give a description of some chemical system in vogue at the present time.

11. Give sketch plan of an infectious diseases hospital of two wards for twelve beds each, and show the position of nurses' duty room, w.cs., beds, doors and windows.

12. State the superficial area and cubic space that should be provided for each patient, and the method of heating and ventilation you would adopt.

SUBJECT:—MUNICIPAL AND LOCAL GOVERNMENT LAW AS RELATING TO THE WORK OF MUNICIPAL ENGINEERS AND SURVEYORS.

Examiner:—Charles Jones, M. Inst. C.E.

1. Give the names of six of the principal Acts now in use in Urban and Rural Districts.
2. Give a short abstract—general purport—of each Act. Not to exceed ten lines in each.
3. Under what particular Act and Section of same may a Rural Authority be invested with the powers of an Urban Authority?
4. Detail the special difference between the provisions of the Public Health Act of 1875 and the Private Street Works Act of 1892, with reference to the making up and apportionment of expenses of Private Streets.
5. Specify the various grounds of Objection which may be taken under the 1892 Act against the Surveyor's apportionment.

PUBLIC HEALTH AMENDMENT ACT, 1890.

6. Into how many "parts" is the above Act divided?
7. Specify the several "parts," and name:—
   (*a*) The compulsory parts.
   (*b*) The adoptive parts.
8. Name the Act—and the particular item of duty set forth—under which a Surveyor is authorised to act without consulting his Council.

SUBJECT:—BUILDING CONSTRUCTION.

Examiner:—James Lemon, M. Inst. C.E., F.R.I.B.A.

1. Draw a section of a warehouse front wall, 78 feet high, showing the floors, footings and concrete foundation, in accordance with the model bye-laws. The length of the wall on plan not to exceed 46 feet.
2. Draw plan of floor to a room, 24 feet by 18 feet, with fireplace, and specify the scantlings of all timbers.
3. Draw a figured section of a wrought-iron girder over a shop, 20 feet clear span, to carry front wall of house, two stories, 23 feet total height, and the floor joists of two rooms; the thickness of the wall to be 1½-brick.

4. Make a sketch elevation of King post roof, 24 feet span, and figure scantlings of timbers; principals to be 10 feet apart.

5. The same in iron, and figure sections of the different parts; also state those in compression and those in tension.

6. Write specification of the interior of a ward of an infectious diseases hospital.

7. Describe method of construction of a fire-proof floor for artisans' dwellings.

8. Write specification for lead flat, and make sketches of rolls and drips.

BOARD OF EXAMINERS.

O. **Claude Robson**, M. Inst. C.E. (*President.*)

The President of the Association (*ex-officio*).

Lewis Angell, M. Inst. C.E., F.R.I.B.A., Fellow of King's College, London, Borough Engineer, West Ham (Past President).

H. P. **Boulnois**, M. Inst. C.E., Local Government Board, Whitehall (Past President).

J. **Cartwright**, M. Inst. C.E., Borough Surveyor, Bury, Lancashire (Past President).

W. **Santo Crimp**, M. Inst. C.E., F.G.S., M.S.I., 27 Great George Street, S.W.

J. T. **Eayrs**, M. Inst. C.E., Corporation Street, Birmingham (Past President).

E. B. **Ellice-Clark**, M. Inst. C.E., 34 Victoria Street, S.W. (Past President).

A. M. **Fowler**, M. Inst. C.E., 1 St. Peter's Square, Manchester (Past President).

C. **Jones**, M. Inst. C.E., Surveyor to the Urban District Council, Ealing, W. (Past President).

W. G. **Laws**, M. Inst. C.E., City Engineer, Newcastle-on-Tyne (Past President).

James Lemon, M. Inst. C.E., F.R.I.B.A., Consulting Engineer, Southampton (Past President).

Jos. **Lobley**, M. Inst. C.E., Borough Engineer, Hanley (Past President).

Francis J. C. **May**, M. Inst. C.E., Borough Engineer, Brighton (Past President).

T. **De** C. **Meade**, M. Inst. C.E., M. Inst. M.E., City Surveyor, Manchester (Past President).

E. **Pritchard**, M. Inst. C.E., 37 Waterloo Street, Birmingham (Past President).

CANDIDATES WHO HAVE PASSED THE EXAMINATION.

Date of Certificate.	
Apr. 23, 1898	Adams, H. C. (Birmingham).
May 7, 1887	Adcock, C. (Liverpool).
May 2, 1891	Allen, S. (Radcliffe).
Apr. 22, 1893	Anderson, H. E. (Norwood).
Apr. 23, 1892	Anderson, J. R. (Norwood).
Apr. 23, 1898	Andrews, S. P. (Tottenham).
Apr. 23, 1898	Andrews, S. H. (Barry).
May 1, 1886	Angell, J. A. (Leytonstone).
May 19, 1894	Angel, R. J. (Birkenhead).
Oct. 20, 1894	Armstrong, J. G. D. (Manchester).
May 1, 1886	Ashmead, H. (Clifton).
Oct. 19, 1889	Aspinall, M. (Cardiff).
Apr. 20, 1895	Atkinson, W. (Bradford).
May 2, 1891	Ball, B. (Middleton).
Oct. 16, 1886	Ball, G. (Scarborough).
Apr. 23, 1892	Ball, J. B. (King's Cross).
May 12, 1888	Barnes, S. W. J. (Ealing).
Oct. 15, 1892	Bassett, G. T. (Birmingham).
May 12, 1888	Bayley, G. H. (Salford).
Oct. 16, 1886	Beard, E. T. (Lincoln).
Apr. 23, 1898	Bell, B. (Carleton).
Apr. 23, 1898	Bennetts, J. P. (Watford).
Apr. 10, 1897	Bentley, J. H. (Oldham).
Apr. 23, 1898	Best, H. S. (Beckenham).
May 12, 1888	Beynon, J. C. S. (Exeter).
Apr. 22, 1893	Birch, J. E. W. S. (Norwood).
Apr. 10, 1897	Bissell, W. S. (Wolverhampton).
Apr. 23, 1898	Blake, E. H. (Balham).
Apr. 13, 1889	Blizard, J. H. (Southampton).
Apr. 23, 1898	Bowe, D. J. (Eastbourne).
Oct. 19, 1895	Boyd, A. (Belfast).
Apr. 13, 1889	Bradley, J. W. (Burnley).
Oct. 21, 1893	Bradshaw, F. E. G. (Brighton).
Oct. 20, 1894	Bradshaw, H. G. (Rochdale).
Apr. 23, 1892	Bradshaw, J. B. (Gateshead).

Date of Certificate.	
Oct. 21, 1893	Brander, J. J. (Aberdeen).
Apr. 23, 1898	Briscoe, J. T. (Enfield).
Nov. 17, 1888	Brown, R. R. (Bridlington Quay).
May 19, 1894	Brown, R. (Ealing).
Oct. 16, 1885	Brownridge, C. (Leeds).
Apr. 25, 1896	Bruce, W. (Edinburgh).
Apr. 22, 1893	Brumell, W. F. G. (Redhill).
May 12, 1888	Bryans, J. G. (Sunderland).
Nov. 17, 1888	Bryning, W. G. (Liverpool).
Oct. 19, 1889	Bucknall, H. (Stratford-on-Avon).
Oct. 20, 1894	Burton, A. (Manchester).
Apr. 13, 1889	Carter, G. F. (Leeds).
Apr. 10, 1897	Cartledge, J. R. (Barnes).
May 3, 1890	Catchpole, J. H. (Hendon).
Apr. 22, 1893	Chasemore, A. E. (Putney).
May 19, 1894	Clarke, A. H. F. (Kingston-on-Thames).
May 19, 1894	Claypoole, A. H. (York).
May 19, 1894	Clegg, H. (Burnley).
Apr. 23, 1898	Clews, A. (Derby).
May 19, 1894	Coales, H. F. (Chelsea).
May 1, 1886	Coales, H. G. (King's Lynn).
Oct. 16, 1897	Coleman, G. S. (West Hartlepool).
Oct. 24, 1896	Collis-Adamson, A. C.
Apr. 22, 1893	Colson, C. H. (Portsmouth).
May 19, 1894	Connah, E. (Glasgow).
Apr. 10, 1897	Cook, F. C. (Hove).
Oct. 22, 1887	Cook, J. (Bury).
May 12, 1888	Cooper, C. H. (Wimbledon).
May 7, 1887	Cooper, F. E. (Liverpool).
May 2, 1891	Cooper, W. (Cheetham).
Oct. 19, 1895	Corrie, H. W. (Birkenhead).
Apr. 20, 1895	Creswell, W. T. (Aldershot).
Apr. 23, 1892	Cross, F. W. (Walsall).
May 12, 1888	Crow, A. (Stratford, E.).
Oct. 16, 1886	Crowther, J. A. (Leeds).
Apr. 23, 1898	Cudbird, T. O. (Norwich).
Apr. 10, 1897	Dakin, E. (Fulham).
Apr. 25, 1896	Dalton, J. P. (Ryton-on-Tyne).
Oct. 21, 1893	Dawson, J. H. (Liverpool).
May 19, 1894	Daye, J. (Cardiff).
May 7, 1887	Dearden, Hy. (Leeds).
Apr. 23, 1898	Dent, J. P. (Nelson).

Date of Certificate.	
Oct. 16, 1897	Dickinson, A. J. (Sheffield).
May 2, 1891	Dixon, J. R. (Carlisle).
Apr. 13, 1889	Dixon, W. B. (Wolverhampton).
Oct. 24, 1896	Dodgeon, A. (Accrington).
Oct. 17, 1891	Dolamore, F. P. (Bournemouth).
Oct. 18, 1890	Dyack, W. (Aberdeen).
Oct. 18, 1890	Edge, F. J. (Barrow-in-Furness).
Apr. 20, 1895	Elford, E. J. (Norwich).
Oct. 16, 1897	Endsor, H. E. (Stony Stratford).
Apr. 23, 1898	Farnham, W. A. (Westminster).
Apr. 25, 1896	Fell, P. O. (Norwich).
May 1, 1886	Fenton, W. C. (Sheffield).
Nov. 17, 1888	Field, W. C. (Eastbourne)
May 12, 1888	Finch, A. R. (Finchley).
Apr. 23, 1898	Finch, E. E. (Bermondsey).
Apr. 22, 1893	Finglah, F. J. (Walsall).
Apr. 10, 1897	Fisher, R. (Greenwich).
Apr. 23, 1893	Fitton, G. (Reading).
Apr. 20, 1895	Forbes, A. H. (Tottenham).
Oct. 19, 1895	Fox, S. F. L. (Batley).
May 7, 1887	Franks, T. W. (West Bromwich).
Apr. 23, 1898	Fraser, R. W. (Wolverhampton).
Oct. 19, 1889	Gaffney, F. S. B. (Athleague).
May 3, 1890	Gibbs, L. (Walsall).
May 12, 1888	Glass, S. N. (Hackney).
May 12, 1888	Gloyne, R. M. (Manchester).
Oct. 16, 1897	Godfrey, C. H. (Manchester).
Oct. 21, 1893	Gordon, Junr., J. (Aberdeen).
Apr. 10, 1897	Grant, F. T. (Maidstone).
May 2, 1891	Graves, M. D. (York).
May 1, 1886	Greatorex, A. D. (Toxteth Park).
Oct. 20, 1894	Green, W. S. (Derby).
Oct. 15, 1892	Greenwood, J. P. (Barry).
Apr. 25, 1896	Griffiths, H. (London, W.C.).
Oct. 16, 1897	Grimley, F. C. (Wisbech).
Apr. 10, 1897	Haigh, W. H. (Cardiff).
Oct. 18, 1890	Hall, W. (Ealing, W.).
Oct. 24, 1896	Harding, W. D. (Malvern).
Nov. 17, 1888	Hawkins, I. T. (Chichester).
Apr. 25, 1896	Haywood, S. S. (Accrington).
Oct. 24, 1896	Hayward, T. W. A. (Weston-super-Mare).
Oct. 15, 1892	Hellawell, O. (Withington).

Date of Certificate.	
Apr. 20, 1895	Hendry, J. S. (West Bromwich).
Oct. 20, 1894	Hickes, E. W. (Truro).
Apr. 25, 1896	Hills, O. C. (Bow).
Apr. 23, 1892	Hills, H. J. (Clapham).
Apr. 20, 1895	Hodgkinson, G. (Manchester).
Apr. 25, 1896	Hogbin, L. W. (Minster).
Oct. 19, 1895	Horne, B. (Stourbridge).
May 12, 1888	Houghton, J. (King's Heath).
Oct. 20, 1894	Hughes, A. H. (Wrexham).
May 2, 1891	Hurd, H. (Bath).
Apr. 23, 1898	Hurst, G. F. (Coalville).
Oct. 17, 1891	Ingham, W. (St. Helen's).
Oct. 16, 1886	Jameson, M. W. (Leeds).
Apr. 10, 1897	Jeffes, R. H. (Clapton).
Oct. 19, 1895	Jenkin, C. J. (Llandudno).
Apr. 20, 1895	Jenkins, A. J. (Rochdale).
Apr. 10, 1897	Jenkins, R. J. (Portsmouth).
Oct. 24, 1896	Johnston, R. W. (Birkenhead).
Apr. 20, 1895	Julian, J. (Cambridge).
Apr. 22, 1893	Killick, W. H. (Southampton).
Apr. 25, 1896	Kieser, W. H. G. (Torquay).
Apr. 25, 1896	Kirk, J. W. (Westminster).
Oct. 15, 1892	Lacey, G. W. (Kettering).
Oct. 19, 1895	Liversedge, J. W. (Fulham).
Apr. 23, 1892	Lloyd, C. (Chatham).
Apr. 20, 1895	Lobley, F. J. (Hanley).
May 12, 1888	Lynam, G. T. (Barnsley).
Oct. 16, 1886	Mallinson, T. (Selby).
Oct. 18, 1890	Manley, J. (Liskeard).
Oct. 21, 1893	Martin, E. B. (Leeds).
Oct. 16, 1897	Marks, C. W. (Eccles).
Apr. 23, 1898	Matthews, E. R. (Hastings).
Apr. 23, 1898	Maurice, C. J. K. (Aylesbury).
Apr. 25, 1896	Maxwell, W. H. (Leyton).
Apr. 23, 1898	May, C. G. (Ipswich).
Oct. 22, 1887	Mellor, T. E. W. (Stockton).
Oct. 22, 1887	Metcalf, J. W. (York).
Apr. 10, 1897	Mewton, J. R. (Carlisle).
May 3, 1890	Miller, J. E. (Durham).
Nov. 17, 1888	Millington, J. S. (Wavertree)
May 12, 1888	Milnes, G. P. (Wakefield).
Apr. 10, 1897	Nash, W. T. (Chiswick).

Date of Certificate.		
Oct. 17, 1891	..	Naylor, W. (Wolverhampton).
Apr. 13, 1889	..	Nettleton, H. (Leeds).
Apr. 20, 1895	..	Newham, J. T. (Birmingham).
Oct. 20, 1894	..	Newton, E. B. (Carlisle).
May 7, 1887	..	Nichols, A. E. (Leeds).
May 7, 1887	..	Nickols, F. J. (Leeds).
Apr. 25, 1896	..	Nightingale, C. F. (Walsall).
Oct. 19, 1889	..	Noakes, H. S. (Tunbridge Wells).
Oct. 24, 1896	..	Norris, J. H. (Godalming.)
Apr. 23, 1898	..	Oakden, R. (Manchester).
Oct. 20, 1894	..	Openshaw, J. (Sheffield).
May 1, 1886	..	Osborne, F. (Dover).
Oct. 20, 1894	..	Palliser, W. A. (Mexboro).
Oct. 24, 1896	..	Pare, W. (Rushden).
Oct. 22, 1887	..	Parker, W. (Hereford).
Apr. 23, 1898	..	Parr, F. H. (Barnes).
Oct. 15, 1892	..	Parr, N. (Walsall).
Oct. 20, 1894	..	Perkins, J. (Balsall Heath).
Oct. 15, 1892	..	Perkins, T. L. (Bristol).
Oct. 16, 1897	..	Perry, G. (Hanley).
Oct. 16, 1886	..	Pickering, J. S. (West Bromwich).
Oct. 21, 1893	..	Pickering, S. A. (Burnley).
Oct. 21, 1893	..	Pickles, G. H. (Burnley).
Apr. 20, 1895	..	Poulden, G. E. (Southsea).
Oct. 16, 1897	..	Prescott, A. E. (Luton).
Oct. 19, 1889	..	Preston, T. (Bradford).
May 19, 1894	..	Price, A. J. (Brighton).
May 12, 1888	..	Pritchard, T. (Richmond).
Apr. 22, 1893	..	Putman, W. E. (Leeds)
Apr. 23, 1898	..	Quick, A. H. (Newlands).
Apr. 10, 1897	..	Redfern, J. L. (Hanley).
May 7, 1887	..	Rich, E. W. (Hounslow).
Oct. 17, 1891	..	Roberts, F. (Birkenhead).
Oct. 24, 1896	..	Rushton, E. (Cleethorpes).
May 2, 1891	..	Saise, A. J. (Stapleton).
May 1, 1886	..	Saunders, E. E. (Walthamstow).
May 7, 1887	..	Saunders, J. (Newark).
Oct. 21, 1893	..	Savage, E. B. (Sheffield).
Oct. 22, 1887	..	Saville, R. W. S. (Accrington).
May 19, 1894	..	Settle, J. A. (Darwen).
Apr. 23, 1892	..	Shackleton, C. W. (Coseley).
Oct. 16, 1886	..	Silcock, E. J. (Leeds).

Date of Certificate.	
Oct. 20, 1894	Slater, W. (Nottingham).
Oct. 16, 1897	Smith, G. H. (New Malden).
May 19, 1894	Smith, W. (Swanage).
Apr. 23, 1898	Spink, J. (Manchester).
Oct. 21, 1893	Steele, W. J. (West Hartlepool).
Apr. 13, 1889	Stringfellow, W. (Southampton).
Oct. 18, 1890	Sumner, F. (Kilburn).
Apr. 23, 1898	Sutton, W. F. (Birmingham).
Oct. 16, 1886	Sykes, E. (Reddish).
Apr. 13, 1889	Taylor, W. J. (Southampton).
Oct. 20, 1894	Thackeray, F. (Darwen).
Apr. 23, 1898	Thomas, H. (Bristol).
Oct. 16, 1886	Thomas, R. J. (Carnarvon).
Oct. 19, 1889	Thomas, T. (Neath).
Apr. 23, 1898	Tiffin, T. E. (West Hartlepool).
Apr. 23, 1898	Tippetts, R. (Lambeth).
Apr. 13, 1889	Tomes, G. B. (Eastbourne).
May 19, 1894	Trew, G. H. M. (Lavender Hill, S.W.).
Oct. 16, 1886	Turner, V. H. (Leeds).
Apr. 20 1895	Uren, F. C. (Penzance).
Apr. 23, 1892	Veit, L. J. (Ipswich).
May 7, 1887	Verschoyle, B. (Liverpool).
Apr. 22, 1893	Videan, Hy. (Stratford, E.).
Oct. 22, 1887	Ward, F. D. (Manchester).
Apr. 10, 1897	Warren, A. R. (St. John's, S.E.).
Apr. 10, 1897	Webb, F. (Chelsea).
Oct. 16, 1997	Wells, F. B. (Bristol).
Oct. 16, 1897	Weston, A. (Paddington).
Apr. 20, 1895	Williams, D. S. (Mountain Ash).
Apr. 23, 1898	Willis, E. (Kilburn).
May 12, 1888	Wilson, C. L. N. (Bacup).
Apr. 23, 1898	Wilson, F. (London, E.).
Nov. 17, 1888	Wilson, J. B. (Cockermouth).
May 1, 1886	Witts, J. W. (Skelton).
May 3, 1890	Wood, J. W. (Rochdale).
Apr. 23, 1898	Worrall, E. (Penmaenmawr).
Oct. 20, 1894	Worrall, F. (Leicester).
Oct. 24, 1896	Worthington, A. (Stockport).
Oct. 15, 1892	Wright, J. A. (Bristol).
May 2, 1891	Yarwood, Hy. (Rochdale).
Apr. 23, 1892	Yates, F. S. (York).
Oct. 16, 1886	Young, W. (Pendleton).

Memoirs of Deceased Members.

The Council having been requested to append some short notice of the decease of Members of this Association, will feel obliged by early notice being forwarded to the Secretary, with such particulars as it may be desirable to insert in these 'Proceedings.'

Sir Robert Rawlinson, born at Bristol on the 28th February, 1810, began life as a working stonemason.

In 1836 he was in the service of Robert Stephenson as assistant engineer on the Blisworth section of the London and North-Western main-line, where so much difficulty was experienced. In 1840 he returned to Liverpool, as assistant surveyor to the Corporation, and it was doubtless in this post that his attention was turned from civil engineering proper to the subject to which he devoted the energies of his long life—sanitary engineering and the promotion of healthy conditions of existence, more especially among the dense populations of our larger towns. He was one of the first inspectors appointed on the passing of the Public Health Act of 1848. In this capacity, he visited and inspected numbers of towns all over the country, and exposed the overcrowding, the lack of drains and sewers, the absence of a wholesome water supply, and the general want of cleanliness.

No episode of Sir Robert Rawlinson's long life was more remarkable than his experiences in the Crimean war, as a member of the sanitary commission of three, who were sent out by Lord Palmerston to inquire into the wretched condition of the troops. The commissioners were invested with full powers to carry out the works they considered necessary. The widespread distress in Lancashire, in consequence of the American civil war, gave Sir Robert Rawlinson another opportunity of distinguishing himself in the service of his fellow-men, and of this, needless to say, he fully availed himself. As the resutl of this report, after visiting over ninety places, nearly 2,000,000*l.* were spent in works of "utility, profit and ornament," in order to provide employment. The works consisted chiefly of permanent improvements of a beneficial character, such as main sewerage, drainage, forming and completing streets, making new water reservoirs, and laying out parks and recreation grounds. Thus, to a very large extent, the evil effects which result from a distribution of doles were avoided.

When the Local Government Board was constituted he became chief engineering inspector, and in 1888, upon retiring from the post after holding it for sixteen years, he was promoted to be K.C.B., having been knighted in 1883, and made C.B. on the completion of his great work in Lancashire. He was chairman of the Royal Commission on the Pollution of Rivers in 1866, and also served on the Commission which inquired into the sanitary condition of Dublin in 1879. He became an associate member of the Institution of Civil Engineers in 1848, member in 1866, and president in 1894. At the meetings of that body he took a prominent part in connection with discussions on drainage and water supply.

Sir Robert Rawlinson was elected an Honorary Member of this Association in May 1873.

Edmund Rothwell, born at Darwen on the 28th October, 1858, began his engineering career as a pupil to the late Mr. John Cunliffe, surveyor to the Darwen Local Board. After remaining with that gentleman for some years as an assistant, he was appointed in 1883, surveyor to the Local Board of Norden, near Rochdale. In May 1867 he became secretary, and in the following November manager and secretary to the Bury, Rochdale and Oldham Steam Tramway Company, which posts he held until his death. During that period he carried out works of permanent way reconstruction costing 25,000*l*. Mr. Rothwell died at Southport on the 6th February, 1898. (Excerpt Min. Proc. Inst. C.E. vol. cxxxii.)

Mr. Rothwell was elected a Member of this Association on the 19th December, 1885.

William Spooner Till was born in Birmingham in 1830, and was educated at King Edward's Grammar School in that city. In 1846, at the age of sixteen, he was articled to Mr. John Piggott Smith,* who was at that time surveyor to the Commisioners under the Birmingham Streets Act. In 1851 the Town Council was formed, Mr. Piggott Smith being appointed the first borough surveyor, which office he held until 1857, when he was succeeded by Mr. Till, who had been assistant surveyor under him.

---

* Minutes of Proceedings Inst. C.E., vol. xxi. p. 594.

It is stated that when Mr. Till took charge of the Surveyor's Department in 1857 the centre of the town was little better than a network of narrow streets, while some of the roads in the borough were studded with ruts and holes, one street being so bad in this respect that some of the holes had to be fenced round and lighted after dusk to prevent accidents. Under the municipal government this state of things was entirely altered. Numerous works of street improvements and sewering were undertaken, and from the time of his appointment as borough surveyor until his retirement from the active duties of that office to the post of consulting surveyor in 1896, Mr. Till was busily employed, his department increasing until his position became that of the head of a large staff. During his surveyorship many street improvements were carried out, particularly in the centre of the city, which was practically remodelled, chiefly owing to the formation of Corporation Street and to the extensions of the railway stations belonging to the London and North-Western and Midland Companies, whilst other public works carried out comprise the erection of the fish and vegetable markets, interception works, the inverting and deepening of the River Rea and Hockley Brook, the construction of about 14 miles of double and 6 miles of single line of tramway, and the laying out of the City Cemetery at Witton (about 100 acres in extent) and of various parks and recreation grounds.

In 1877 the Birmingham Tame and Rea Drainage District was formed, comprising the Borough of Birmingham, the Local Government districts of Ashton Manor, Handsworth, Smethwick, Balsall Heath, Harborne and Saltley, and portions of the rural sanitary districts of Ashton, King's Norton and West Bromwich, enlarged in 1881 by the addition of the parish (now borough) of Sutton Coldfield. Mr. Till was appointed engineer to the Joint Board, his principal duties being the promotion of facilities for joint intercepting works, and the purification of the sewage, the dry weather flow of which is now about 22 million gallons per day.

In 1881 Mr. Till prepared a scheme for the acquisition and laying out of about 1000 acres of land for an irrigation farm, in addition to the system of purification by lime in tanks then in operation; and subsequently negotiated the purchases and carried out the extensive works necessary for putting the scheme into execution. In 1896 he recommended the extension of the farm to practically double its then area, and an Act was obtained empowering the Board to purchase the land and carry out the works.

Mr. Till died at his residence in Holyhead Road, Handsworth, on the 22nd February, 1898. A most efficient municipal officer, he not only enjoyed the confidence of the City Council and Drainage Board, but his reputation for sound judgment and fairness was such that his advice was frequently sought in disputes and questions of difficulty arising in connection with the suburban sanitary authorities. In the discharge of his duties he not only proved himself an able engineer, but also an excellent man of business. He was courteous and kindly in manner and a firm friend, being much esteemed not only in private life, but also by the large staff over which he presided, and by the many professional and public men with whom his official position brought him into contact. (Excerpt Mins. Proc. Inst. C.E., vol. xxxii.)

Mr. Till was elected a Member of this Association May 16th, 1874.

Thomas Higginson, late surveyor to the Local Board, Widnes. Mr. Higginson was elected a Member of this Association on the 18th December, 1886.

William Tuley, late surveyor of the Urban District Council Rothwell, near Leeds, died suddenly on the 4th June, 1898. Mr. Tuley was elected a Member of the Association on the 27th June, 1895.

OCT 30 1916

LONDON: PRINTED BY WILLIAM CLOWES AND SONS, LIMITED, STAMFORD STREET
AND CHARING CROSS.